MINERAL DEVELOPMENT DIVISION
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

GEOLOGY OF THE FACHEUX BAY AREA (11P/9), NEWFOUNDLAND



by

R. Frank Blackwood

Report 85-4

St. John's, Newfoundland
1985

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Mineral Development Division
Department of Mines and Energy
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Cover: PUSHTHROUGH, Newfoundland - one of the many resettled communities in the Facheux Bay map area. Field assistant Morris West is "pushing through" the high-water shortcut that gave the community its name. Push-through is underlain by banded McCallum Granite.

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ABSTRACT

The Facheux Bay area on Newfoundland's south coast is partly underlain by metasedimentary and metavolcanic rocks of the Baie d'Espoir Group. The group forms a narrow belt in the central part of the map area and is subdivided into the Isle Galet Formation, the Riches Island Formation and the Little Passage Gneiss. A zone of synkinematic granitoids intrudes the Baie d'Espoir Group in the south; a massive to weakly deformed granite intrudes the group in the north.

Felsic volcanic rocks and turbidites of the Isle Galet Formation are the lateral time-stratigraphic equivalents of psammites and pelites of the Riches Island Formation. These rocks are affected by two, locally overturned, regional F_1 folds, viz. the Manuel Arm Anticline in the south and the Northern Arm Syncline in the north. Regional metamorphism increases structurally downward on the overturned limb of the anticline, culminating in amphibolite facies metasedimentary rocks and migmatites of the Little Passage Gneiss (defined as a lithodemic unit of the Baie d'Espoir Group). The second deformation of the Baie d'Espoir Group resulted in upright F_2 folds locally.

The structurally lowest, and highest metamorphic grade rocks of the Baie d'Espoir Group occur in the south where they are intruded by coarse grained, feldspar porphyritic, biotite granitoids, viz. the McCallum and Gaultois granites. These plutonic rocks were intruded during the first regional deformation of the Baie d'Espoir Group and are overprinted by the penetrative S_1 foliation. The massive to weakly foliated North Bay Granite intrudes the Baie d'Espoir Group in the north. This pluton, with its associated thermal aureole, postdates D_1 structures in the country rocks and is interpreted as a syn D_2 granite.

A number of base metal showings occur in the Isle Galet Formation, mostly associated with felsic tuffs.

INTRODUCTION

Location and Access

The map area is located at, and west of, the entrance to Bay d'Espoir on the south coast of Newfoundland. It is bounded by 47°30' and 47°45' north latitude and 56°00' and 56°30' west longitude. A portion of the Hermitage Peninsula that occurs in the southeast corner of the map area is not included in this study.

The Facheux Bay (11P/9) map area is accessible by small boat out of St. Alban's and Hermitage, the two closest communities with road links. McCallum, a tiny fishing community and the only settlement in the map area, is a regular stop on CN Marine's south coast ferry run. Northern Arm and Facheux Bay provide two complete sections through the area and permit accessibility to most of the inland terrain.

Previous Work

Alexander Murray made reference to the rocks on Long Island in his Geological Survey of Newfoundland report for 1870 (Murray and Howley, 1881). He presumed that granite gneiss in the south and paragneiss in the north were of different ages and probably were separated by an unconformity.

Jewell (1939) included part of Long Island and rocks east of Northern Arm on his 1 inch to 1 mile map of the Baie d'Espoir area. He outlined and named the Baie d'Espoir series and the North Bay Granite. High grade metamorphic rocks (gneisses and schists) on Long Island were considered conformable with the rest of the series, having been remobilized by granite intrusion in the contact area. Felsic volcanic rocks in the Stanley Cove - Western Head area were described as quartzite.

The Baie d'Espoir series east of the Facheux Bay area was mapped by Anderson (1965) as part of the 1:250,000 Belleoram map area. He later changed the name Baie d'Espoir series to Bay d'Espoir Group (Anderson, 1967) and concluded that the sedimentary rocks graded southward into paragneiss and paraschist.

The Facheux Bay area forms part of the larger Burgeo map area that was mapped on a 1:250,000 scale by the Geological Survey of Canada (Williams, 1971a). Metasedimentary rocks of the Baie d'Espoir Group were shown to grade southward into schist and gneiss, culminating in a southern terrane of granite gneiss and foliated granite.

Parts of the Facheux Bay area were briefly examined by Colman-Sadd (1974) during a detailed study of the Bay d'Espoir area (Colman-Sadd, 1976; Colman-Sadd et al., 1979). He divided the Baie d'Espoir Group into four formations: the Isle Galet, Riches Island, St. Joseph's Cove and Salmon River Dam. The group was redefined to exclude metasedimentary rocks, migmatites and some foliated granitoid rocks that occur in the southern part of the area. These rocks of higher metamorphic grade were named the Little Passage Gneiss and interpreted as a Precambrian basement to the Ordovician sedimentary and volcanic rocks of the Baie d'Espoir Group. The Day Cove Thrust, defined near the northern shore of Long Island, was described as separating the overlying Baie d'Espoir Group cover sequence from the basement gneisses.

A number of sulfide showings were discovered in felsic volcanic rocks of the Facheux Bay area by the Newfoundland and Labrador Corporation (Dunlop, 1954); some of these were trenched. These rocks were also the focus of an exploration program by Falconbridge Nickel Mines Ltd. (Hinchey, 1978).

Swinden (1980, 1982) included felsic volcanic and associated rocks (Isle Galet Formation) of the Facheux Bay area into a regional metallogenic study of the Bay d'Espoir area. He concluded that the volcanic rocks displayed proximal to distal facies variations along strike and were host to several minor stratabound sulfide occurrences. A similar but larger study included the geology and mineral potential of south-central Newfoundland (Colman-Sadd and Swinden, 1982).

Present Investigation

The present study is a contribution to the Canada-Newfoundland Cooperative Mineral Program, 1982-84. Under that program, regional mapping of the Hermitage Flexure area along Newfoundland's south coast was carried out. Systematic, 1:50,000 scale mapping of the Facheux Bay (11P/9) map area was completed during the 1982 field season (Blackwood, 1983). Metasedimentary and metavolcanic rocks were defined as part of the Isle Galet and Riches Island Formations of the Baie d'Espoir Group. Stratigraphic, structural and metamorphic analyses of these rocks indicate progressive metamorphism southward into a synkinematic granitoid and migmatite terrane. A relatively late, little deformed granite bounds the Baie d'Espoir Group to the north.

Physiography

The coastline of the Facheux Bay area is generally characterized by steep imposing cliffs that have maximum elevations between 200 and 300 metres. Facheux Bay itself is a long, deep fiord that trends perpendicular to the east-west

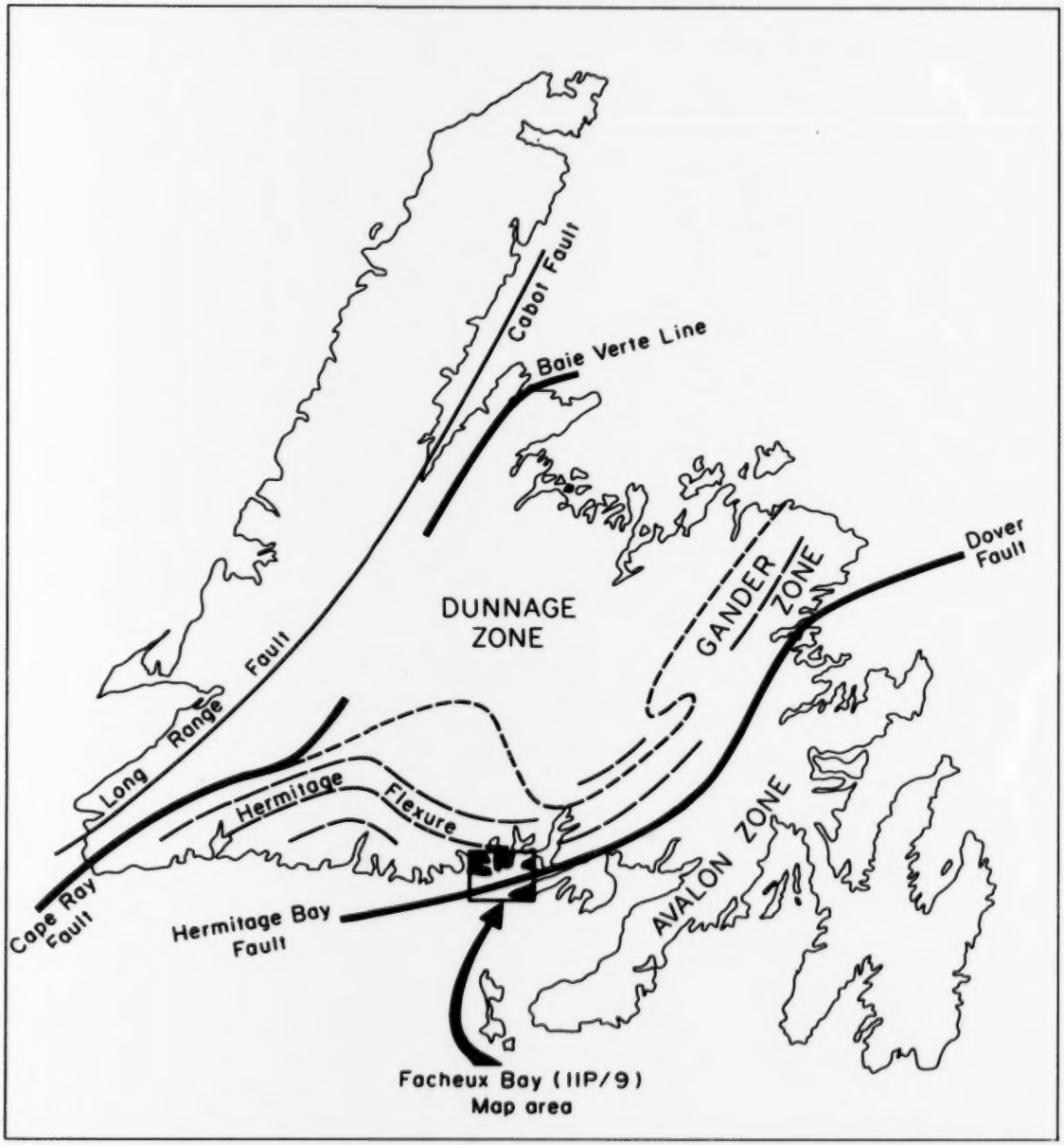


Figure 1: *The Facheux Bay map area in relation to the Gander Zone and the Hermitage Flexure.*

structural grain, providing a nearly continuously exposed section through the west-central part of the map area. Northern Arm, at the entrance to North Bay, also forms a deep north-south channel in the east.

The inland area is dominated by a profusion of small ponds and a myriad of hills with maximum elevations not exceeding 400 metres. Within the bedded succession of the Baie d'Espoir Group, the ridges are parallel to the regional strike; deep gullies and linear ponds commonly occur between them. In the southern foliated granitoid terrane, the abrupt hills and narrow ponds do not reflect the structural grain as markedly as those in the central area. In the northwestern area, inclusion free, unfoliated granite forms broad, gently sloped hills that contrast sharply with the rest of the map area.

The inland area is mostly a barren terrain, variably covered by a thin veneer of brush-supporting peat. Wet boggy areas containing stunted juniper (larch) are also common. Otherwise the land surface consists of weathered, lichen covered outcrop. Large trees are rare except for spruce, fir and minor birch that occur in some of the narrow bays and valleys along the coast.

Most of the landform features are controlled by the geological strike with the notable exceptions of Facheux Bay and North Bay - Northern Arm. These north-south fiords, locally containing hanging valleys, reflect the direction of ice movement. Till cover is thin or nonexistent in the map area.

GENERAL GEOLOGY

General Statement

The Facheux Bay (11P/9) map area is located at the junction of northeast trending structures of eastern Newfoundland with east trending structures of southwestern Newfoundland (Fig. 1). The change in strike is a continuous one and results in the sinuous Z-shaped configuration of rock units along the south coast known as the Hermitage Flexure (Williams et al., 1970). Rocks along the flexure have been metamorphosed to varying degrees and intruded by a variety of granitoids. They thus form a southern crystalline belt which is continuous with metamorphic and granitoid rocks of northeastern Newfoundland; collectively these crystalline rocks have been referred to as the Gander Zone (Williams, et al., 1974).

The Gander Zone in northeastern Newfoundland consists mostly of a Lower Ordovician or earlier psammitic metasedimentary sequence that also includes some quartz arenite, arkose, semipelite, pelite, minor mafic tuff and amphibolite. Metamorphic grade increases progressively from greenschist facies in the west to upper amphibolite facies in the east, resulting in an eastern zone of paragneiss and migmatite (Blackwood, 1977, 1978). These rocks are intruded by foliated and unfoliated, feldspar megacrystic, biotite granites and two-mica granite-granodiorites. A hornblende-hornfels facies (Winkler, 1967) aureole is associated with some of the two-mica granites.

The Gander Zone is limited eastward by the Dover-Hermitage Bay Fault (Blackwood and Kennedy, 1975; Blackwood and O'Driscoll, 1976). The fault is a major mylonite-breccia zone that juxtaposes Precambrian rocks of the Avalon Zone (Williams et al., 1974) against migmatites and deformed granites of the Gander Zone.

The western boundary of the Gander Zone in northeastern Newfoundland is marked by a conformable change in lithofacies; the largely psammitic rocks of the Gander Zone grade westward and southwestward into Middle Ordovician turbidites and felsic volcanic rocks (Blackwood, 1982) of the central Newfoundland Dunnage Zone (Williams, 1979). Locally the boundary between the two zones is modified by faults along which ophiolitic rocks (Gander River Ultrabasic Belt) have been emplaced (Jenness, 1958; Blackwood, 1982). Thus, the generally quartz-rich, possibly shelf facies rocks of the Gander Zone are easily contrasted with the relatively unmetamorphosed volcaniclastic turbidites of the Dunnage Zone in the west. However, no such clear geological or geographical boundary occurs between metamorphic rocks of the Hermitage Flexure area and rocks in central Newfoundland. In fact, the metamorphic rocks along Newfoundland's south coast are more akin in age and facies to the Middle Ordovician turbidites and volcanics of the Dunnage Zone than they are to the Lower Ordovician or earlier metasedimentary rocks of the northeastern Gander Zone. Thus it appears that two entirely different environments of deposition are represented by the southern and northern parts of the Gander Zone. However, despite these differences, both areas have two features in common:

(1) A progressive increase in metamorphic grade which occurs in a southeastward or southward direction, culminating in a zone of paragneiss and migmatite adjacent to the Dover-Hermitage Bay Fault.

(2) Distinctive granitoid rocks of similar composition, texture and age.

Although rocks in the Hermitage Flexure area of the Gander Zone appear to be the highly deformed and metamorphosed equivalents of the adjacent Dunnage Zone (see also, Chorlton, 1980, 1983), the concept of a *Gander Zone* as a metamorphic belt with distinctive granite intrusions is still useful. Its boundary with the Dunnage Zone is either a metamorphic gradation or the approximate limit of Gander Zone intrusions. Also, these rocks consistently occur between the Dunnage and Avalon Zones in the Newfoundland Appalachians.

Metasedimentary and metavolcanic rocks in the Facheux Bay area are considered part of the Middle Ordovician Baie d'Espoir Group (Jewell, 1939; Anderson, 1967; Colman-Sadd, 1976, 1980b). Except for a small intervening area of granite intrusion and migmatite development west of Facheux Bay, these rocks are continuous westward with similar rocks (Blackwood, 1984; O'Brien and Tomlin, 1984) in the Hermitage Flexure area where they are defined as the Ordovician Bay du Nord Group (Cooper, 1954; Chorlton, 1980). The Bay du Nord Group and its probable temporal equivalent, the La Poile Group (Cooper, 1954; Chorlton, 1978, 1980), are considered to have been deposited upon oceanic crust (Chorlton, 1983; O'Brien, 1983). Similarly, Colman-Sadd (1980b) interpreted at least part of the Baie d'Espoir Group to have had an ophiolitic basement. This is consistent with correlatives of the Baie d'Espoir Group in the northeastern part of the Dunnage Zone where the Middle Ordovician Davidsville Group (Kennedy and McGonigal, 1972) sits upon ophiolitic rocks (Blackwood, 1982). There is, however, no direct evidence for an ophiolitic basement

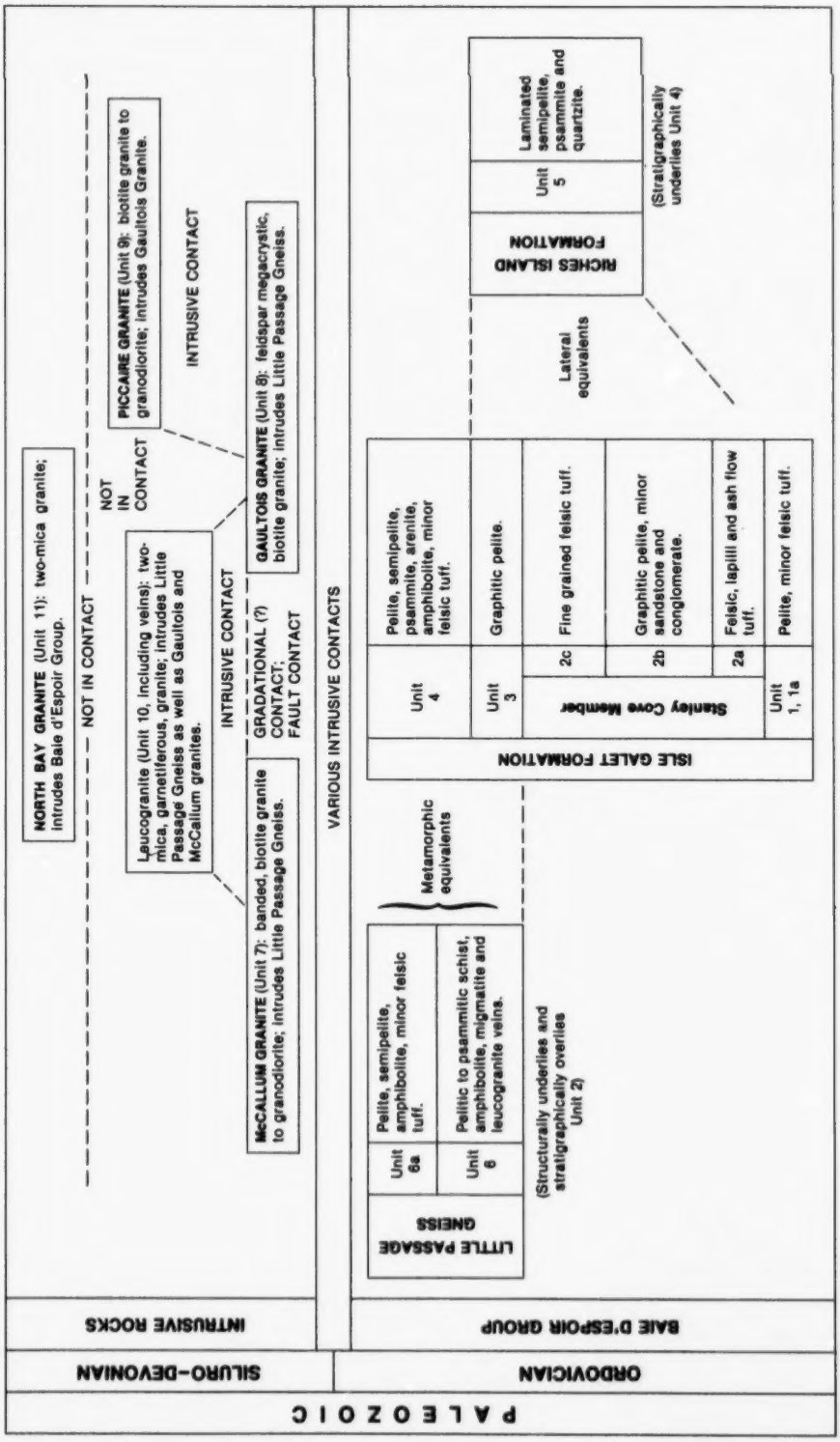


TABLE 1: *TABLE OF FORMATIONS*

to the Baie d'Espoir Group in the Facheux Bay map area. Also, migmatites previously interpreted as a possible continental basement (Colman-Sadd, 1974, 1976, 1980b) are here interpreted as part of a conformable succession within the Baie d'Espoir Group.

Rocks in the Facheux Bay map area are grouped into three broad subdivisions:

(1) A central, west thinning zone of metasedimentary and metavolcanic rocks, viz. the Isle Galet Formation, the Riches Island Formation, and the Little Passage Gneiss of the Baie d'Espoir Group.

(2) A southern zone of synkinematic granitoids, viz. the McCallum Granite, the Gaultois Granite, the Piccaire granite, and leucogranite.

(3) A northern area of weakly deformed granite, viz. the North Bay Granite.

The Baie d'Espoir Group is disposed around two upright to south facing, large scale folds, here termed the Northern Arm Syncline and the Manuel Arm Anticline. The syncline occurs north of the anticline and is overturned in the east: the anticline is overturned to recumbent in the east, becoming steeply inclined to the west. Regional metamorphism increases downward on the overturned limb of the Manuel Arm Anticline, culminating locally in migmatite. The high grade region was intruded synkinematically by mostly biotite granites. The northern part of the Baie d'Espoir Group is intruded by a biotite-muscovite granite with a well developed thermal aureole that post dates the main foliation (S_1).

Middle Ordovician or Earlier

Baie d'Espoir Group

Definition and Division

The sedimentary rocks in the Bay d'Espoir area were named the Baie d'Espoir series by Jewell (1939). He tentatively assigned a Silurian age to the series and considered the variably metamorphosed rocks as part of a conformable sequence. Felsic volcanic rocks were erroneously described as quartzites.

The Baie d'Espoir series was assigned by Anderson (1965) to the Middle Ordovician based on new (Anderson, 1967) and earlier fossil discoveries (Dunlop, 1954). Anderson (1967) also changed Baie d'Espoir series to Baie d'Espoir Group. He divided the group into four structural zones: the fourth or most southerly zone included the rocks in the eastern part of the Facheux Bay map area. Rocks in this fourth structural zone were described as "increasing in metamorphic grade southward where they grade into paragneiss and paraschist."

Williams (1971) extended the Baie d'Espoir Group westward to Facheux Bay, made clear reference to the change in name from series to group, and provided more detail on the fossil occurrences upon which an Ordovician age was based.

The geological development of the Bay d'Espoir area was the subject of a Ph.D. thesis by S.P. Colman-Sadd (1974). He redefined the Baie d'Espoir Group and assigned the higher grade metamorphic rocks in the southern part of the area, principally on and east of Long Island, to a basement gneiss complex. These schists, paragneisses and migmatites were named the Little Passage Gneiss and considered to be of Precambrian age. The Ordovician Baie d'Espoir Group was interpreted as a cover sequence in tectonic contact with the older gneisses. Structures in the gneisses were said to become re-worked with proximity to this contact, defined as the Day Cove Thrust along the north shore of Long Island (Colman-Sadd, 1976, 1980b; Colman-Sadd et al., 1979). Colman-Sadd (1976) also formally divided the Baie d'Espoir Group into four formations which, from north to south in the Bay d'Espoir area, are:

(1) *Salmon River Dam Formation;* mainly sandstone and siltstone.

(2) *St. Joseph's Cove Formation;* mainly pelite and siltstone.

(3) *Riches Island Formation;* mainly phyllite and psammite.

(4) *Isle Galet Formation;* mainly acid and basic volcanic rocks, phyllite and psammite.

Further mapping (Colman-Sadd, 1980a) northward and inland resulted in the definition of a fifth formation:

(5) *North Steady Pond Formation;* mainly sandstone, siltstone, pelite and felsic volcanic rocks.

All five formations are gradational and interpreted as partly lateral equivalents (Colman-Sadd, 1980b).

Only two formations of the Baie d'Espoir Group, as defined by Colman-Sadd, occur in the Facheux Bay (11P/9) map area. The Riches Island Formation outcrops on the northern limb of the east-west trending Northern Arm Syncline and is therefore

older than the top of the Isle Galet Formation which outcrops in its core. However, the lower part of the Isle Galet Formation, which outcrops on the southern limb of the syncline, may be the lateral equivalent of the Riches Island Formation.

The Isle Galet Formation is in contact with the Little Passage Gneiss. Although some fault movement may have occurred along the boundary on Long Island, relationships described in this report indicate that it is not a significant dislocation or structural re-working zone. In fact, stratigraphic, structural and metamorphic analyses combine to indicate a conformable relationship between the Isle Galet Formation and the Little Passage Gneiss. Therefore the schists, paragneisses, and migmatites are here included in the Baie d'Espoir Group as in the original definitions of Jewell (1939) and Anderson (1967). The name Little Passage Gneiss (Colman-Sadd, 1974) is retained for these higher grade metamorphic rocks of uncertain internal stratigraphy, and is defined as a lithodemic unit within the Baie d'Espoir Group.

The Baie d'Espoir Group forms a west thinning zone in the central part of the Facheux Bay map area. It is approximately 11 km wide in the eastern Lampidoes Passage-Long Island area and narrows to approximately 1.5 km at the western boundary of the map area. The group is limited southward by the foliated, coarse grained, McCallum and Gaultois granites. It forms part of an intrusion breccia zone with the coarse grained North Bay Granite along its northern boundary.

Age

A Middle Ordovician age is indicated for at least part of the Baie d'Espoir Group. Fossils discovered northeast of the Facheux Bay map area have been identified as *?Eotamaria sp.* (Dunlop, 1954), *Streptelasma* and crinoidal debris (Anderson, 1967; Williams, 1971), and Orthid cf. *Orthambonites*, Orthid cf. *Productorthis*, and Syntrophid (Colman-Sadd, 1976).

Isle Galet Formation (Units 1 to 4)

Definition and Division

Colman-Sadd (1976) defined metavolcanic and metasedimentary rocks in the southern part of the Baie d'Espoir Group as the Isle Galet Formation. Two of the most distinctive and common rock types in the formation are gray or black graphitic pelite and felsic tuff. The Isle Galet Formation forms an arcuate belt of rocks in the central part of the Facheux Bay map area. It narrows from east to west, pinching out in a zone of granite intrusion and migmatite (Little Passage Gneiss) approximately 5 km west of Facheux Bay. It is bounded to the north by the Riches Island Formation and to the south by the Little Passage Gneiss.

The Isle Galet Formation is divided into four units and two subunits in the Facheux Bay map area. These units are disposed around two overturned folds: the Northern Arm Syncline and the Manuel Arm Anticline. Pelite and minor felsic tuff (Unit 1, 1a) occupy the core of the anticline. These are conformably overlain by felsic volcanic rocks (Unit 2) that have been informally called the Stanley Cove member (Swinden, 1980), a name that is formally proposed in this report. A narrow band of graphitic pelite, conglomerate and limestone (subunit 2b) forms a distinct stratigraphic horizon in the felsic volcanic rocks and is included in the Stanley Cove Member. Black graphitic pelite (Unit 3) overlies the Stanley Cove Member and is gradational into a sequence of litharenite, pelite, amphibolite and minor felsic tuff (Unit 4) of the upper part of the Isle Galet Formation.

Unit 1

Distribution

Unit 1 occupies the core of the Manuel Arm Anticline. Except for Facheux Bay, it is continuous from Manuel Arm in the east to the limit of the Isle Galet Formation in the west. Its outcrop width varies from 100 to 900 m, controlled in part by the degree of inclination of the fold's axial plane. Subunit 1a occurs as a 150-200 m wide band within Unit 1 west of Facheux Bay.

Description

Unit 1 consists mostly of gray to grayish black pelite with a pronounced phyllitic foliation. The pelite is locally graphitic and commonly laminated; laminae are 0.5 to 5 mm wide and subparallel to the main foliation. Minor 2 to 6 cm thick semipelite and psammite beds occur in Unit 1 as do concordant amphibolite bands. The pelite is locally richly garnetiferous: the garnets range from 1 to 4 mm across and decrease in size and profusion toward the northern contact of Unit 1, e.g. Davy Downs Cove, Manuel Arm. Quartz stringers and boudins are common in the pelite and these, too, decrease in abundance with proximity to the northern contact. Locally, halos rich in garnet porphyroblasts surround some of the quartz pods in the southern part of Unit 1 at Manuel Arm. Concordant leucogranite dikes containing garnet and tourmaline intrude Unit 1 west of Bonne Bay.

White to grayish white weathering, 3 to 20 m thick felsic tuff bands are commonly intercalated with the pelite. These are best observed along the shore and north cliff face of Manuel Arm. Distinct 1 to 2 mm quartz and feldspar crystals occur in some of these bands. Locally, zones of light gray weathering, slightly more siliceous phyllite within the darker gray pelite may represent tuffaceous beds. Subunit 1a, west of Pacheux Bay, is a gray to grayish white weathering phyllite that forms a distinct 150 to 200 m wide unit within the more graphitic pelites. Probably tuffaceous in origin, it commonly contains pyrite and profuse quartz veins, also pyritiferous. Felsic tuff also forms 3 to 4 metre wide bands in Unit 1 west of Pacheux Bay and, in a few places, occurs as 2 to 4 cm interbeds.

Petrography

A strongly oriented weave of muscovite and biotite, in varying proportions, is dominant in the pelites. Quartz exceeds feldspar in the quartzofeldspathic component and both commonly form elongate (rectangular) grains with straight boundaries; these occur throughout the mica weave and/or form discrete quartzofeldspathic lenses or laminae. Quartz is generally granoblastic in the pressure shadows of garnet porphyroblasts. Anhedral grains of hornblende occur in quartzofeldspathic bands in semipelite west of Pacheux Bay. Garnet, biotite, chlorite, cordierite(?), and staurolite form porphyroblasts with garnet the most common. Snowball, sigmoidal, and straight inclusion trails of elongate quartz and minor opaques are characteristic of the garnet porphyroblasts. Cordierite(?) is everywhere pinitized and locally the staurolite is altered to sericite and chlorite. Some biotite is also altered to chlorite; zircon, tourmaline and sphene occur as accessory minerals. The tuffaceous phyllites included in Unit 1 locally contain muscovite and biotite laminae in granoblastic to granoblastic elongate, quartzofeldspathic material. Rare patches of polycrystalline sutured quartz, clear quartz grains, and minor plagioclase grains probably represent original clasts. Subunit 1a also contains partially recrystallized quartz clasts in a granoblastic, quartz-rich matrix. Muscovite is the main mica, and it forms an oriented felted mass in laminae and lenses.

Structure and Metamorphism

The main foliation in Unit 1 is mostly a phyllitic fabric with local occurrences of a very fine grained schistosity. It has gentle to moderate northward dips east of Pacheux Bay; west of Pacheux Bay, the fabric dips steeply to the north. Interpreted in the field as the first foliation or S_1, it is axial planar to isoclinal folds of bedding, primary laminae, and quartz veins. Locally, rootless fold hinges are defined by isolated lenses of quartz. A variably oriented crenulation cleavage or S_2 overprints the main foliation.

The metamorphic grade appears to increase in Unit 1 from mid to upper greenschist facies in the north to lower amphibolite facies in the south, where the rocks are gently to moderately dipping at Manuel Arm. Garnets are larger and more profuse near the southern contact and quartz veining is most pronounced in that general area. The garnets both overgrow the main foliation and form augen within it. Where Unit 1 is steeper at, and west of, Pacheux Bay, the metamorphic grade appears uniform throughout.

The main foliation in Unit 1 is defined by strongly oriented muscovite and biotite, and locally, by oriented elongate quartz. In the field, this appears to be the first tectonic fabric, and there is no evidence of any folding prior to its development. However, inclusion trails in metamorphic porphyroblasts, principally garnet, suggest a more complex history. Garnets that occur as augen in the main fabric planes commonly have inclusion trails (Si) that show internal rotation (Plate 1) and make various angles with the external or main foliation (Se). S-shaped

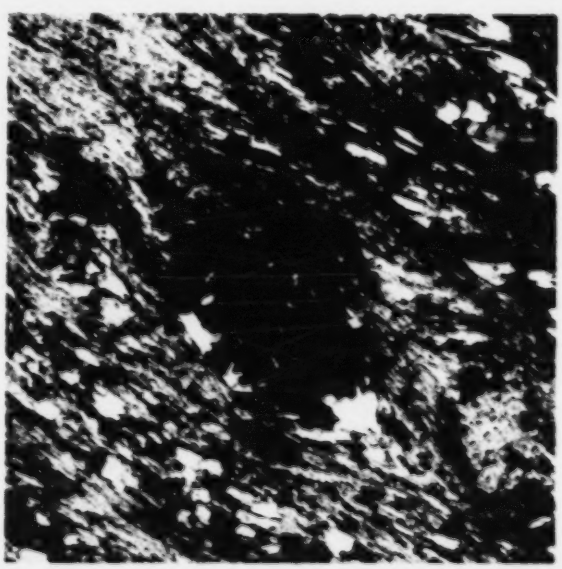


Plate 1: *Photomicrograph of syntectonic to posttectonic garnet containing a rotational core in semipelite. Note massive posttectonic growth at upper right corner of the crystal. Unit 1 of the Isle Galet Formation at Manuel Arm. Cross polarized light; field of view is 2.5 mm across.*

trails locally show rotation of 90° or more, merging with and becoming parallel to Se at the garnet rims. Other garnets have "snowball" cores and massive rims that overgrow the main fabric. Still others have straight trails that form large angles with Se and occur as augen in Se or have straight trails that are parallel to Se in overgrowing porphyroblasts. All of the above porphyroblast/microfabric relationships may be seen in the same thin section and are interpreted to represent syntectonic crystallization of garnet during and slightly after the development of the main foliation. To what extent the inclusion trails (Si) represent an earlier tectono-metamorphic event is not fully understood. Rarely, intrafolial folds defined by fine grained muscovite and biotite occur between the main foliation planes. These and the inclusion trails may indicate that the main foliation is the result of a second deformation. However, the later, variably oriented crenulation cleavage may also produce similar textural relationships (de Wit, 1976) where the axial planes of the microcrenulations are subparallel to the pre-existing foliation. Finally, the control of a primary anisotropy, particularly in mica-rich pelites, on subsequent metamorphic textures is a factor to be considered. The intrafolial folds, for example, are not defined by bent micas but by polygonized micas that outline the microfolds. Thus it is possible that this apparently earlier orientation may represent folding of detrital phyllosilicates that had a primary orientation parallel to bedding and were subsequently mimetically recrystallized during development of the main foliation; some of the inclusion trails may have had a similar origin.

Other synkinematic porphyroblasts include cordierite and staurolite. The cordierite occurs as completely pinitized clots that form a slight augen structure in the main foliation. Staurolite was only found in the southern part of Unit 1 at Manuel Arm and along both sides of Facheux Bay. The anhedral to subhedral crystals mostly overgrow the main foliation but locally have curved inclusion trails, e.g., at Facheux Bay. Garnet also appears to overgrow the margins of staurolite porphyroblasts. Biotite porphyroblasts everywhere overgrow the main foliation.

Retrogressive metamorphism, possibly associated with the late crenulation cleavage, is demonstrated by the local alteration of some biotite and garnet to chlorite and the development of cross-cutting chlorite porphyroblasts. Staurolite is partially altered to sericite and chlorite. Minor chlorite is also oriented along the axes of the microcrenulations is some areas.

Contact Relationships

Unit 1 is conformable along both its northern and southern boundaries with felsic tuffs of Unit 2. In the contact areas, narrow bands of felsic tuff occur in the pelites and up to 10 m wide pelitic layers are intercalated with the tuffs.

Stanley Cove Member (Unit 2)

Definition and Division

A zone of felsic volcanic rocks within the Isle Galet Formation west of Facheux Bay was informally named the Stanley Cove member by Swinden (1980). The name was taken from a small cove on the west side of Northern Arm, an area where the zone of felsic volcanic rocks is well exposed. Since these volcanic rocks form such a distinctive unit and useful marker horizon within the Isle Galet Formation, formal adoption of the name *Stanley Cove Member* is proposed in this report.

The Stanley Cove Member consists mostly of white to grayish white weathering, fine to coarse grained, felsic crystal tuff. Although the tuffs become finer grained and probably represent a more distal facies at opposite ends of the member in the Facheux Bay map area, the Stanley Cove section is fairly representative of the volcanic rocks in the area between Facheux Bay and Lampidoes Passage.

A penetrative foliation is developed in the Stanley Cove Member, related to the large scale, southward facing, Manuel Arm Anticline. The volcanic rocks are disposed along both limbs of this structure forming two major east-west trending zones (Fig. 2). The northern zone is on the normal or upward facing limb, has the larger outcrop width, and is more representative of the member. A narrow band less than 200 m wide, of mostly graphitic pelite, minor conglomerate, sandstone and limestone (2b) forms a continuous marker horizon throughout the northern zone of the Stanley Cove Member. It effectively divides the felsic tuffs into lower (2a) and upper (2c) stratigraphic units. This sedimentary band is generally missing from the southern zone of felsic tuffs that occurs on the bottom or overturned limb of the anticline. There the tuffs form a narrower zone, in part because of tectonic attenuation, and the largely pelitic subunit 2b was the probable site of some fault movement at Manuel Arm and west. This assumed fault divides the southern zone into two subunits: one of strongly recrystallized and deformed tuff containing profuse leucogranite veins ($2c_1$) south of the fault, and one of less deformed, nearly granite-free tuff north of the fault ($2a_1$). The abrupt change in the amount of leucogranite veining, and variations in the

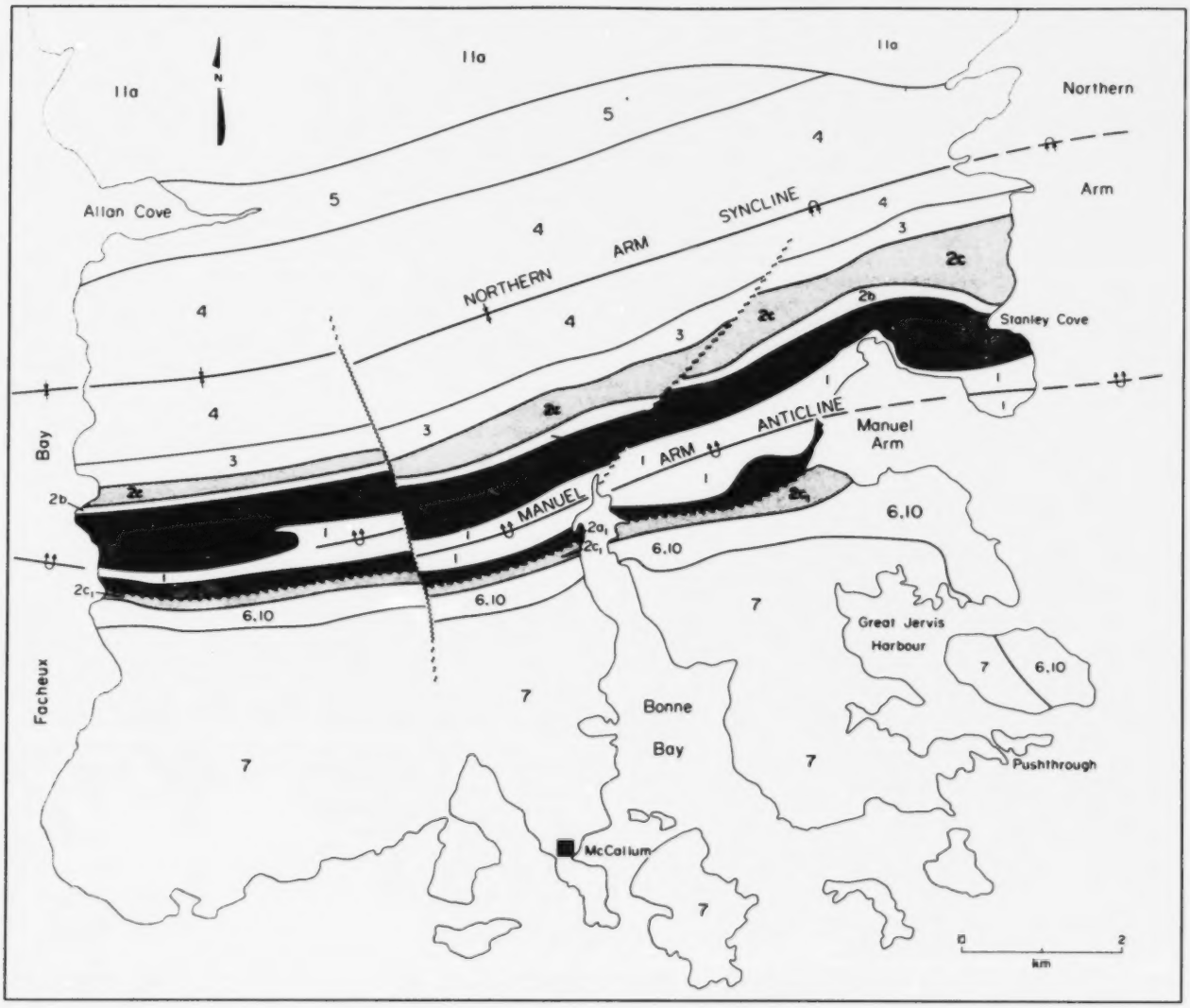


Figure 2: *Distribution of the Stanley Cove Member on the upper limb or northern zone (2a, 2b, 2c) and lower limb or southern zone ($2a_1$, $2c_1$) of the Manuel Arm Anticline in the Facheux Bay - Northern Arm area (Units numbered as on 1:50,000 map sheet).*

degree of recrystallization are the best evidence for a fault separating subunits $2a_1$ and $2c_1$ in this area. Farther east along the north shore of Long Island, the southern zone of the Stanley Cove Member contains the pelitic subunit $2b_1$ and is free of any significant leucogranite veining along this part of the overturned limb.

Distribution

The Stanley Cove Member on the northern or normal limb of the Manuel Arm Anticline forms a zone that extends from Bois Island in the east to an area just west of Dennis Arm in Facheux Bay, where it apparently pinches out stratigraphically. It has an outcrop width of approximately 1.7 km at its widest point in the Stanley Cove area. On the bottom limb, the member forms a narrow southern zone along the north shore of Long Island, including Grip Island, and extends from Manuel Arm, in the east, to the limit of the Isle Galet Formation west of Facheux Bay: there it is lost in a zone of metamorphic remobilization and granite intrusion. Its widest outcrop width is approximately 0.8 km in the Manuel Arm area. The Stanley Cove Member is estimated to be 800 to 1000 m thick at the Stanley Cove section.

Description

Northern Zone (Upper Limb of Manuel Arm Anticline)

Subunit 2a is the lowest stratigraphic division of the Stanley Cove Member. It consists of gray, laminated, slightly phenoclastic, felsic tuffs on the contact with Unit 1 pelites south of Stanley Cove. The quartz and feldspar clasts are 1 to 3 mm across and the laminae are 2 to 10 mm wide. These well foliated tuffs grade northward into a more massive and siliceous, grayish white weathering rock that superficially resembles a porphyritic rhyolite. It consists of 1 to 5 mm quartz and feldspar phenocrysts in a very fine grained, massive matrix. Feldspar crystals generally are larger and greater in number than quartz: some of the quartz is translucent. The presence of lithic clasts, however, suggest that these more massive volcanics probably originated as ash flow tuffs.

A 10 to 15 m band or lense of volcanic conglomerate (Plate 2) occurs within the ash flow tuffs south of Stanley Cove. The clasts consist mostly of felsic volcanic material, are 1 to 15 cm long, and have been flattened and oriented within the main foliation planes. Elongate pelite and semipelite clasts also occur. The conglomerate matrix consists of 2 to 3 mm quartz and feldspar clasts which are themselves surrounded by a much finer grained felsic matrix.



Plate 2: *Volcanic conglomerate containing mostly felsic volcanic clasts, subunit 2a of the Stanley Cove Member, just south of Stanley Cove.*

The highly siliceous, massive looking tuffs are characteristic of the lowest subunit (2a) of the Stanley Cove Member. These may be clearly seen in the south facing cliffs of Goblin Head where individual white weathering flows are separated by thin layers and lenses of dark gray pelite (Plate 3). The ash flows generally vary from 0.5 to 5 m in thickness and some pinch out along strike. The intervening pelite bands are 8 to 80 cm thick. Locally the base of an ash flow appears to have reacted slightly with the underlying pelite, marked by a change to a darker gray color in the volcanic rocks along the contact. Rarely, fine grained lapilli tuff separates the ash flows.

Fine to coarse grained, bedded lapilli tuffs are intercalated with the more massive ash flows west of Stanley Cove. These are marked by profuse quartz and feldspar clasts that are 0.5 to 3 mm across and occur in a very fine grained felsic matrix. The lapilli tuffs are mostly above the ash flows at the Stanley Cove section where grading in the tuffs (Plate 4) indicate that these rocks are younging northward. Fine to coarse grained lapilli tuffs also outcrop in subunit 2a west of Facheux Bay. However, in the extreme east, on Bois Island, the tuffs are markedly different.



Plate 3: *Individual ash flows (3 to 5 m thick) separated by thin pelite layers, subunit 2a of the Stanley Cove Member, on the south facing cliffs of Goblin Head.*



Plate 4: *Graded lapilli tuff consisting of quartz and feldspar clasts, subunit 2a of the Stanley Cove Member on the normal limb of the Manuel Arm Anticline at Stanley Cove.*

There they are very thinly and regularly laminated (Plate 5). The laminae vary from 1 to 15 mm in thickness with most between 4 and 10 mm, and are marked by varying shades of gray. Scattered throughout this well laminated felsic material are isolated quartz eyes, locally with a blue hue.



Plate 5: *Thinly and regularly laminated distal felsic tuff, subunit 2a of the Stanley Cove Member on Bois Island.*

The top of subunit 2a of the Stanley Cove Member is marked by an abrupt but conformable contact with a narrow, generally less than 200 m wide band of mostly clastic sedimentary rocks (2b). Commonly, however, a narrow layer of grayish white weathering marble, 1.5 to 2 m thick, occurs on the contact at the base of subunit 2b at Pacheux Bay, Goblin Head and Copper Head. The marble at Goblin Head (Plate 6) sits above a 60 cm thick zone of crystal tuff that becomes progressively more calcareous from bottom to top. Dark gray marble lenses, 1 to 3 cm wide, and pyrite rich layers and lenses give this marble band a crudely laminated appearance. A similar relationship between calcareous crystal tuff and marble occurs at Copper Head on Bois Island where the bottom of subunit 2b is exposed in a north trending fault zone. At Stanley Cove itself, the marble occurs as 0.5 to 4 cm thick carbonate layers and lenses, interlayered with very fine grained siliceous material that may be chert.

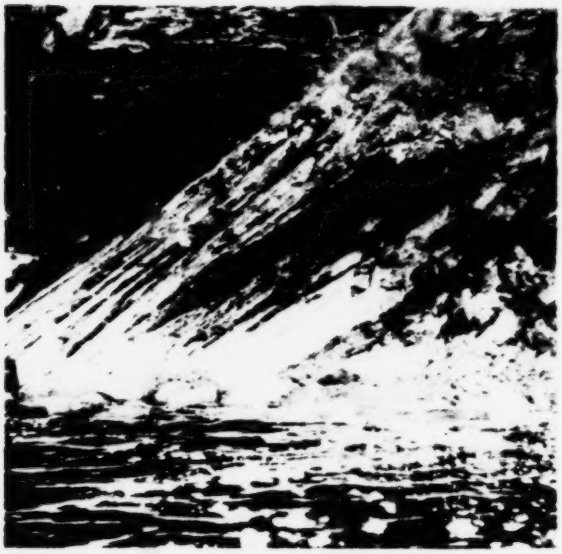


Plate 6: *A two metre thick band of marble (centre of photograph) overlies felsic tuff (2a) and is overlain by black graphitic pelite at the base of subunit 2b of the Stanley Cove Member at Goblin Head.*



Plate 7: *Coarse grained sandstone with interbedded graphitic pelite, subunit 2b of the Stanley Cove Member in brook section north of Bonne Bay.*

Black graphitic pelite with a strong phyllitic to finely schistose fabric everywhere overlies the marble and is the most common rock type of subunit 2b. However coarser clastics also occur within the pelites and the section along the brook flowing into Bonne Bay provides the best exposed examples of these sandstones and conglomerates. In the southern part of this section, black, pyritiferous, laminated pelite and siltstone are interbedded with medium to coarse grained sandstone beds that vary from 0.5 to 45 cm in thickness (Plate 7). Locally, bedding is discontinuous and the sandstones lense out into the black pelite: the reverse also occurs. Upsection, in areas of mostly sandstone, beds are 20 to 80 cm thick and contain 2 to 5 mm lenses and 2 to 4 cm beds of black pelite and sandstone. The sandstones comprise 1 to 2 mm quartz and feldspar clasts, locally in a fine grained quartzofeldspathic matrix, but most commonly in a black pelitic matrix. Some of the quartz clasts have a distinctive blue hue. Lithic clasts are common throughout and range from 0.5 to 30 cm in length. Black pelite intraclasts occur in the sandstone but felsic volcanic clasts with quartz and feldspar phenocrysts are the most numerous. The larger lithic clasts generally occur as isolated fragments that "float" in the sandy or pelitic beds (Plate 8). Bedding surfaces are



Plate 8: *Large felsic volcanic clast surrounded by black graphite pelite, subunit 2b of the Stanley Cove Member in brook section north of Bonne Bay.*

wrapped around some of these isolated clasts. In parts of the brook section, the various clastic components are chaotically intermingled such that pebbles, cobbles, and wisps of sandstone, are surrounded by black pelite. Grading occurs in some of the sandstone beds; one bed was noted to face south but most, particularly near the top of the section, faced north. Also, near the top of subunit 2b, a profusion of pebbles and cobbles are supported by a partially coherent matrix of siltstone and sandstone lenses, giving the rock a conglomeratic appearance. Most of the clasts are volcanic but one clast of plagiogranite was noted. Locally, thin lenses of marble, 4 to 3 cm thick and up to 3 m long, are found within the black graphitic pelite and, on Bois Island, an apparently coherent 2 to 3 m wide felsic tuff band occurs.

Felsic tuffs of the upper part (2c) of the Stanley Cove Member conformably overlie the narrow clastic band (2b). These tuffs are generally finer grained, less massive and contain fewer quartz and feldspar clasts than tuffs of subunit 2a. In fact, fine grained, strongly foliated, felsic material devoid of any phenoclasts is common in subunit 2c. Locally, however, quartz-rich lapilli tuff with very fine grained tuffaceous interbeds are developed, such as just above subunit 2b at the Stanley Cove section. Laminated felsic tuffs with a few phenoclasts contain minor zones of possible mafic tuff in subunit 2c at Goblin Head. The mafic rocks are greenish-gray weathering and have 2 to 8 mm wide laminae; disoriented hornblende crystals are developed on the bedding planes. Locally, 1 to 3 cm wide bands of amphibolite occur within the mafic tuffs. Also within the felsic tuffs of subunit 2c at Goblin Head are two stretched pebble conglomerate horizons. One is just above the contact with subunit 2b and is approximately 1 m thick; the other is farther up in the section and is approximately 3 m thick. The pebbles are of felsic volcanic origin and although mostly poorly sorted, there is a crude suggestion of grading with younging to the north. Minor siliceous tuffs similar to the ash flows below subunit 2b at Goblin Head occur in subunit 2c on Western Head at the entrance to Lampidoes Passage. These appear to be above subunit 2b but possible faulting like that at Goblin and Copper Heads may have displaced the clastic marker horizon, making the true stratigraphic position of these flows uncertain.

Southern Zone (Lower Limb of Manuel Arm Anticline)

The lowest stratigraphic division ($2a_1$) of the Stanley Cove Member in the southern zone is the highest structural one since it occurs on the overturned limb of the south facing anticline. Lithologic differences between it and its stratigraphic equivalent on the upper limb are partly due to lateral variations within the volcanic sequence. However, the more intense deformation of the bottom limb would almost certainly make similar elements more difficult to recognize.

Subunit $2a_1$ of the southern zone contains fine grained tuffs that are pinkish white to grayish white weathering. Crystal clasts are scattered throughout and consist of quartz and feldspar augen which range from 1 to 4 mm across; locally the quartz has a blue hue. Laminae are a common feature and vary from 1 to 5 mm in width. Beds of tuff range from 4 to 70 cm in thickness on the west side of Facheux Bay; elsewhere, such as at Manuel Arm, a variably spaced, prominent parting parallel to the laminae may mark individual beds. The main tectonic foliation is finely penetrative and parallel to bedding. Locally interleaved with the tuffs are zones of pelite/semipelite that may be up to 7 m thick. One such zone in Bonne Bay contains a 1 m band of amphibolite. Rarely, garnet porphyroblasts occur in the felsic volcanic rocks.

Little or no granite veining occurs in subunit $2a_1$ of the southern zone. However, rare "knots" of quartz, feldspar and, locally, tourmaline do occur, particularly west of Facheux Bay. In that area the volcanic rocks appear to be in conformable contact with amphibolite facies metapelites to the south; only in the extreme west do leucocratic granite veins intrude both the volcanic and metasedimentary rocks right along the contact.

The largely pelitic subunit $2b_1$ does not, for the most part, occur in the southern zone of the Stanley Cove Member. It is assumed that its structural position on the bottom limb of the overturned anticline, an area of tectonic attenuation, makes it the ideal locus for fault movement between the two felsic volcanic subdivisions at Manuel Arm and west. However, a garnetiferous pelitic schist zone containing quartz and pegmatite veins just south of Hatcher Cove, Bonne Bay, near the contact between the two felsic subunits $2a_1$ and $2c_1$, may be a higher metamorphic grade remnant of subunit 2b. An approximately 100 m wide band of graphitic pelite subdivides the felsic tuffs along the north shore of Long Island. Interpreted as the stratigraphic equivalent of subunit 2b, these pelites are finely schistose and contain profuse garnet porphyroblasts and quartz segregations.

The structurally lowest subunit of felsic volcanic rocks ($2c_1$) in the southern zone of the Stanley Cove Member is unique in the Manuel Arm and west area. It is marked by a higher grade of metamorphism

and the intrusion of leucogranite veins. The tuffs are rusty pink weathering and commonly pyritiferous. Primary textures have been mostly destroyed in this strongly flattened, highly recrystallized zone. However, the occurrence of 2 to 5 mm quartz augen probably represent original phenoclasts. Garnet and muscovite porphyroblasts, 1 to 2 mm across, are common. The white weathering leucogranite occurs as concordant sheets and lenses of muscovite rich, garnetiferous pegmatite and aplite: locally they represent 50 percent or more of the outcrop area of subunit $2c_1$. Also, "knots" and stringers of quartz, and quartz plus plagioclase, form 4 to 10 mm thick welts in the recrystallized volcanic rocks (Plate 9). Although the granite-intruded zone ends relatively abruptly at the assumed fault between it and the clearly tuffaceous subunit $2a_1$, the local occurrence of granite welts and garnet porphyroblasts in subunit $2a_1$ indicates an overall metamorphic continuity between subunits $2a_1$ and $2c_1$.



Plate 9: *Quartz and granitoid welts in recrystallized felsic tuffs, subunit $2c_1$ of the Stanley Cove Member on the overturned limb of the Manuel Arm Anticline at Bonne Bay.*

Subunit $2c_1$ along the north shore of Long Island is not intruded by distinct garnetiferous leucogranite veins. The tuffs are pinkish to grayish white weathering and contain distinct 2 to 4 mm phenoclasts of quartz and feldspar that form augen in the main fabric planes. However, concordant quartz veins and minor granite welts do occur: the volcanic rocks are also locally garnetiferous. An approximately 2 m thick pelitic band on Grip Island is richly garnetiferous and contains large 1 to 2 cm porphyroblasts that form augen in the main foliation planes: these porphyroblasts are largely altered to chlorite and sericite.

Petrography

Northern Zone (Upper Limb of Manuel Arm Anticline)

Laminae in the fine grained tuffs of subunit 2a are defined by variations in grain size of the quartzofeldspathic matrix and in the amount of plagioclase within individual layers. The scattered phenoclasts consist of quartz, altered plagioclase and potassic feldspar. Sericite, chlorite and fine grained biotite are oriented parallel to the laminae and wrap around the phenoclasts. Zircon and epidote are accessory minerals.

The matrix in the ash flow tuffs consists mostly of fine grained (approximately 0.01 mm), equigranular quartz with diffuse interlocking grain boundaries. Minor amounts of feldspar also form part of the matrix. Calcite occurs in the matrix, and in concordant veins of quartz and carbonate at Goblin Head. Quartz phenoclasts have square, triangular, and round outlines: some have embayments preserved (Plate 10).

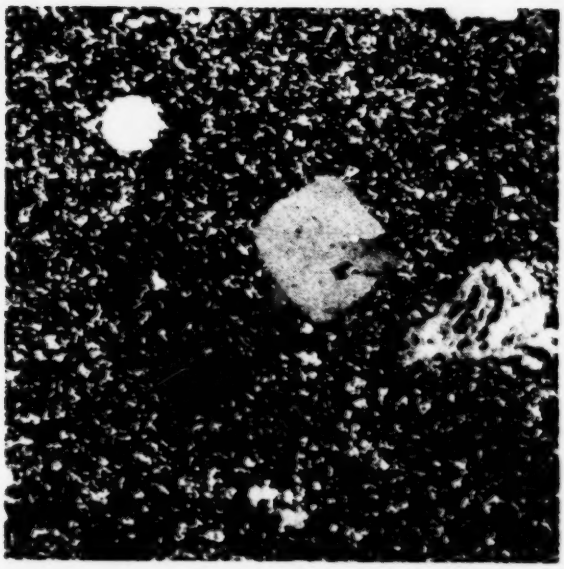


Plate 10: *Photomicrograph of embayed quartz phenoclasts in a fine grained quartz-rich matrix, subunit 2a of the Stanley Cove Member, just south of Stanley Cove. Cross polarized light; field of view is 2.5 mm across.*

These are mostly single crystals but locally quartz forms recrystallized, granoblastic clots. Plagioclase clasts have been sericitized to varying degrees and locally show a possible primary alteration feature where quartz segregations and interfingering twin lamellae produce a ribbon like texture. Perthitic orthoclase and microcline phenoclasts also occur. Sericite, fine grained biotite, and chlorite define the main foliation. Locally, most of the biotite is altered to chlorite. Fine grained muscovite porphyroblasts overprint the oriented micas. Accessory minerals include apatite, zircon, zoisite and sphene.

Crystal clasts in the lapilli tuff are round, angular and euhedral. Both quartz and variably altered plagioclase (An_{24-32}) locally preserve boundary embayments. Orthoclase and minor microcline also occur as phenoclasts. The matrix is quartz rich with either a granoblastic to granoblastic elongate texture, or grain boundaries are curved and diffuse. Sericite, chlorite and minor biotite define the main foliation; locally tiny muscovite porphyroblasts overgrow this fabric, e.g., at Facheux Bay. Subhedral to euhedral apatite and zircon are accessory minerals.

The marble in subunit 2b consists mostly of granoblastic elongate calcite with minor quartz and feldspar grains. Sericite, chlorite, biotite and zircon are accessory minerals. The overlying sandstones comprise round to angular quartz, altered plagioclase, potassic feldspar and lithic clasts. Quartz predominates and is both clear to polycrystalline; pelite clasts consist of biotite, quartz and graphite. Rare epidote clasts also occur. The matrix comprises granoblastic to finely diffuse quartzofeldspathic material and oriented fine grained biotite, chlorite (after biotite), sericite and muscovite. The micas locally form a continuous weave in individual bands and also define the main foliation. Graphite is commonly oriented parallel to bedding or the tectonic fabric. The same micas predominate in the pelitic beds which commonly contain biotite and garnet porphyroblasts. Hornblende porphyroblasts, locally partially altered to chlorite, overgrow the micas at Goblin Head and Bois Island. Also at Goblin Head, stringers of recrystallized carbonate and quartz contain granoblastic calcite which overgrows the micas.

The felsic tuffs of subunit 2c contain quartz and feldspar phenoclasts in a fine grained, quartz rich matrix with diffuse grain boundaries. Minor, fine grained biotite, chlorite and sericite define the main foliation.

Southern Zone (Lower Limb of Manuel Arm Anticline)

Crystal fragments in subunit $2a_1$ felsic tuffs consist of quartz, plagioclase (approximately An_{26}) and perthitic orthoclase that form augen in the mica rich domains. The matrix is more coarsely recrystallized than in the northern zone, consisting mostly of equant, slightly elongate quartz grains with straight to curved boundaries. Laminae are defined by coarse grained quartz-rich bands and fine grained feldspar-rich bands. Biotite and muscovite are present in varying proportions; strongly oriented, tapered crystals locally form narrow continuous bands. Fine grained, fractured, anhedral garnet occurs in the tuffs at Hatcher Cove, Bonne Bay. Accessory minerals include zircon, apatite and opaques. A pelitic band in the felsic tuffs west of Facheux Bay contains a strongly oriented weave of muscovite and biotite with zones of elongate quartz. This is overgrown by staurolite porphyroblasts with straight to slightly curved inclusion trails. Subhedral to euhedral garnets overgrow all other minerals. Locally, thin concordant veins and elliptical welts of granitoid occur within the felsic tuffs. They consist of quartz, plagioclase, and potassic feldspar.

The pelitic band ($2b_1$) in the tuffs at Patrick Harbour on Long Island consists of biotite, lesser muscovite, and quartzofeldspathic material. Chlorite and garnet porphyroblasts overgrow the oriented micas. Fine grained, euhedral apatite crystals are locally concentrated in lenses and overgrow oriented biotite.

Petrographically, the recrystallized and strongly deformed felsic tuffs of subunit $2c_1$ are difficult to distinguish from the similarly deformed concordant leucogranite veins. The matrix or groundmass commonly consists of equigranular quartz, plagioclase and microcline with straight to curved grain boundaries. Slender, tapered crystals of muscovite and biotite define a pronounced foliation. Muscovite is better developed in the leucogranite, and biotite locally exceeds muscovite in the volcanic rocks. Welts of much coarser grained granitoid occur as augen in the fabric planes. Accessory tourmaline appears restricted to the leucogranite component. Probable phenoclasts in recrystallized tuff west of Facheux Bay consist of microcline, plagioclase and quartz. The quartz occurs as isolated, strained grains with finely recrystallized rims in a fine grained quartzofeldspathic matrix. In the same rock, garnet porphyroblasts containing inclusions overgrow strongly oriented biotite, confirming the metamorphic origin of garnet in the tuffs as opposed to the primary magmatic origin of garnet in the leucogranite veins.

Structure and Metamorphism

The first and main foliation in the Stanley Cove Member is mostly a penetrative fabric that is parallel or subparallel to bedding. It has gentle to moderate northerly dips in the central and eastern parts of the map area, and moderate to steep dips in the Pacheux Bay area. On the northern or normal limb of the overturned Manuel Arm Anticline, to which this fabric is axial planar, the foliation is steeper than bedding at Goblin Head and Stanley Cove. Where the tuffs are graded in these areas, they face up on the S_1 fabric planes. These observations, in association with the vergence of small scale F_1 folds, confirm the overall structural and stratigraphic position of the northern zone of the Stanley Cove Member. The more massive ash flow tuffs in the northern zone do not exhibit the fine scale penetrative parting that normally defines the main foliation but, instead, have a widely spaced fracture cleavage.

On the bottom or overturned limb of the Manuel Arm Anticline, the main foliation is more intensely developed than on the normal limb. It is parallel to primary layering, except where axial planar to small scale isoclinal folds, and is a thoroughly penetrative fabric in the concordant leucogranite veins. The degree of flattening is also greater on the overturned limb as indicated by the pronounced augen structures defined by phenoclasts in the tuffs and phenocrysts in the granite sheets. This supports the interpretation that the Stanley Cove Member is attenuated on the overturned limb of the fold.

A widely spaced, variably developed, crenulation cleavage overprints the main penetrative foliation in the Stanley Cove Member. Commonly it has one of two orientations: either concordant with the regional main foliation or at a high angle to it. Dips are variable from gentle to steep. It is preferentially developed in the less siliceous, fine grained tuffs and is also variably developed in pelitic portions of the member: it may be a strong strain-slip fabric in one area and a weak crenulation cleavage in another.

The main foliation in the northern zone of the Stanley Cove Member is mostly phyllitic but locally is very finely schistose where barely visible biotite and muscovite flakes occur. In thin section, the fabric is consistently defined by sericite, muscovite and biotite with some biotite altered to chlorite. The oriented micas are locally overgrown by tiny muscovite porphyroblasts; fine grained biotite and garnet porphyroblasts overgrow the muscovite-biotite fabric in the pelite-sandstone-conglomerate band (2b) within the Stanley Cove Member north of Bonne Bay. Coarser porphyroblasts of biotite, euhedral garnet, and disoriented hornblende, locally partially altered to chlorite, also cross-cut the main foliation in subunit 2b at Goblin Head and Bois Island. Some of these porphyroblasts may be related to the regional metamorphism or to later granite intrusion. The latter interpretation is favored for the eastern area where the overgrowing porphyroblasts and incipient polygonization in the felsic volcanic rocks, at Western Head for example, are interpreted as contact metamorphic effects of near-surface granite (likely part of the North Bay Granite (Unit 11) which outcrops at Pomley Cove just outside the map area; however, its metamorphic aureole is evident along Lampidoes Passage in the Pacheux Bay map area). There is generally no recrystallization along the crenulation cleavage in the central part of the northern zone except for local minor sericite and graphite. However, minor biotite has grown preferentially along S_2 at Goblin Head. Also, muscovite outlines S_2 in the area west of Pacheux Bay where biotite porphyroblasts appear to overgrow the crenulation cleavage.

Biotite and muscovite are much more obvious on the main fabric planes in the southern zone of the Stanley Cove Member. West of Pacheux Bay, muscovite is coarsest grained and most profuse adjacent to the southern boundary of subunit $2a_1$. In thin section, the micas are commonly strained and elongate with tapered ends in the area west of Pacheux Bay. A minor pelitic layer on the west side of Pacheux Bay contains staurolite porphyroblasts with curved to straight inclusion trails; these porphyroblasts are likely of synkinematic origin. Garnet porphyroblasts form slight augen structures to straight overgrowths in the same rock. Fractured, anhedral garnet also occurs in felsic tuff at Bonne Bay. The oriented micas are even coarser in the granite-intruded zone ($2c_1$) and locally are overgrown by subhedral to euhedral garnet porphyroblasts in the recrystallized tuff. The felsic tuffs along the northern shore of Long Island are finely schistose and contain scattered garnet porphyroblasts. A thin pelitic layer within crystal tuff on Grip Island contains porphyroblasts that form augen in the main fabric planes and are altered to sericite, quartz and chlorite; one preserved core of staurolite indicates the original composition of these porphyroblasts. Garnet, biotite and chlorite all form overgrowing porphyroblasts. Chlorite and garnet porphyroblasts also overgrow the biotite-muscovite foliation in subunit $2b_1$ of the Patrick Harbour area.

Contact Relationships

The base of the Stanley Cove Member (2a) forms an abrupt but conformable contact with pelites of Unit 1 in both the northern (Plate 11) and southern (Plate 12) zones. The narrow clastic subunit (2b) also has sharp contacts with the underlying (2a) and overlying (2c) felsic tuffs; the base of subunit 2b is marked by a thin marble layer that sits directly on felsic volcanic rocks in most coastal exposures. A presumed fault separates felsic tuff subunits $2a_1$ and $2c_1$ in the southern zone where leucogranite veins end abruptly at the northern contact of subunit $2c_1$. This boundary also represents the approximate stratigraphic position of the largely pelitic subunit $2b_1$ which is interpreted to be sheared out in the area west of Manuel Arm. The upper boundary of the Stanley Cove Member is a conformable contact with graphitic pelites of Unit 3. On the overturned limb, this contact at Manuel Arm and westward is marked by profuse concordant leucogranite veining in both the felsic volcanic rocks and the structurally lower metasedimentary rocks of Unit 6. Some fault movement may have occurred within pelitic rocks along this boundary in the Long Island area (Day Cove Thrust of Colman-Sadd, 1974), but basically there is structural, metamorphic, and to some degree, lithic continuity between the Stanley Cove Member and the structurally underlying metasedimentary rocks (subunit 6a).



Plate 11: *North dipping felsic tuffs (subunit 2a) of the Stanley Cove Member conformably overlie pelites (Unit 1) on the normal limb of the Manuel Arm Anticline south of Stanley Cove.*

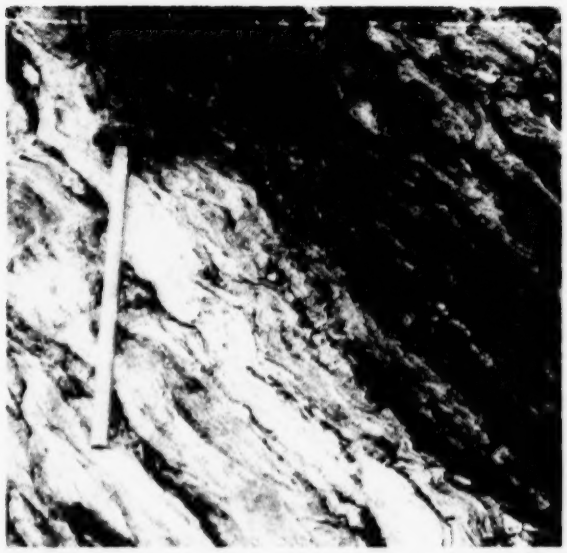


Plate 12: *North dipping pelites (Unit 1) structurally overlie and are conformable with felsic tuffs (subunit $2a_1$) of the Stanley Cove Member on the overturned limb of the Manuel Arm Anticline at Manuel Arm.*

Unit 3

Distribution

Unit 3 sits on the normal limb of the Manuel Arm Anticline, statigraphically above the Stanley Cove Member. It forms a narrow, moderately north-dipping unit with a regular, approximate width of 325 m west of Northern Arm. It has a much wider outcrop width of approximately 1.5 to 2 km eastwards in the Goblin Bay - Lampidoes Passage area where it is refolded by open, upright F_2 folds.

Description

Black weathering, graphitic pelite, with a slatey to phyllitic cleavage is the most common rock type of Unit 3. The pelite is locally laminated with 2 to 10 mm thick laminae; some light gray laminae are more feldspathic in composition. Pyrite is common in the graphitic pelite, as demonstrated by the rusty-yellow staining of cliff faces along the coast. Garnet and hornblende porphyroblasts occur in pelite and semipelite east of Northern Arm; garnet porphyroblasts and quartz segregations are developed west of Facheux Bay. The pronounced slatey cleavage is overprinted by a well developed strain-slip or crenulation cleavage, particularly east of Northern Arm.

A variety of rock types occur as minor interbeds within the largely pelitic sequence, including light gray semipelite, psammite, gray to black argillite, sandstone, felsic tuff and amphibolite. These form mostly thin beds that range from 1 to 15 cm in thickness; locally the argillite beds contain pyrite rich laminae. The concordant amphibolite bands are laminated, fine to medium grained, and up to 2 m thick, e.g., Goblin Bay. A band of felsic tuff, several metres wide, occurs in Unit 3 on the southwest end of Bois Island where it is offset by a north trending dextral fault. Minor sandstone beds were noted at Dennis Arm in Facheux Bay and much more widespread sandstone occurs in the inland area between Goblin Bay and Lampidoes Passage. The quartz-feldspar rich sandy beds in the latter area are graded with sharp bases, laminated tops and a pelitic cap. These are interpreted as partial Bouma sequences containing divisions ABE (Bouma, 1962).

Petrography

Laminated pelite from Lampidoes Passage consists of oriented, fine grained muscovite, biotite, chlorite and graphite alternating with thin (0.5 to 1 mm), granoblastic, quartz-rich laminae containing minor oriented chlorite. Some of the micas are polygonized around the hinges of microcrenulations. The felsic tuff band on Bois Island has a fine grained quartzofeldspathic matrix with irregular, diffuse grain boundaries. Sericitized plagioclase phenoclasts are larger and more profuse than the polycrystalline and single crystal quartz clasts. Poorly oriented, fine grained biotite, sericite and minor muscovite define the foliation. Porphyroblastic biotite also occurs in knots of overgrowing tabular crystals.

Structure and Metamorphism

The main regional foliation (S_1) is a pronounced phyllitic to slatey cleavage which is moderately to steeply dipping west of Northern Arm and gently to steeply dipping in the refolded zone east of Northern Arm. It is mostly coplanar with primary laminae and locally is axial planar to isoclinal folds of quartz veins. The first foliation is overprinted by a variably developed crenulation cleavage (S_2) which is most pronounced east of Northern Arm. In that area, it is a steeply dipping, east trending, locally strain-slip cleavage that is axial planar to gently plunging (east and west), open F_2 folds. The axes of these second folds of S_1 and bedding are regionally parallel to the main foliation and have developed on the northward-dipping normal limb of the Manuel Arm Anticline. This has flattened out the otherwise moderate northward dip of Unit 3, resulting in the larger outcrop area east of Northern Arm. It should be noted that characteristic graphitic pelite predominates in coastal exposures of Unit 3 at Goblin Bay and Lampidoes Passage, but the hilly, north-central part of the area in between is mostly underlain by sandstone. Although these sandstones are included in Unit 3, they are similar to clastics in the overlying Unit 4 and may represent F_2 infolding of the younger rocks.

The first foliation (S_1) is defined by very fine grained biotite, muscovite, sericite, chlorite and graphite. Garnet and hornblende porphyroblasts occur west of Facheux Bay and east of Northern Arm. In the latter area, garnet appears to overgrow S_1 and hornblende forms disoriented crystals on S_0 and S_1 planes.

Contact Relationships

Unit 3 conformably overlies the felsic tuffs (2c) of the Stanley Cove Member. Although the contact is a relatively abrupt one, a 3 m wide band of tuff does occur within Unit 3 pelites just above the contact on the west shore of Northern Arm. Also, black pelite is interbedded with subunit 2c felsic tuff along the contact at Dennis Arm. Unit 3 is conformable along its upper contact with Unit 4, except for some minor faulting northwest of Bonne Bay.

Unit 4

Distribution

Unit 4 is the northernmost unit of the Isle Galet Formation and, at least in part, represents the stratigraphic top of the formation. It also forms the largest outcrop area within the formation with a regular outcrop width of approximately 2.2 km between Facheux Bay and Northern Arm. It narrows considerably before ending in the higher grade, granite-intruded terrane west of Facheux Bay. East of Northern Arm, Unit 4 forms a 0.8 to 1.4 km wide belt. The Northern Arm Syncline is sited within the southern part of Unit 4. Subunit 4a represents three small areas of amphibolite of uncertain origin; two occurrences are on the east side of Facheux Bay and one is on the west side of Northern Arm.

Description

Unit 4 consists of a variety of rock types with three predominating: gray and black graphitic pelite, amphibolite, and medium to coarse grained sandstone. Felsic crystal tuff, mafic tuff, semipelite and psammite form a minor component of the unit.

Graphitic pelite occurs throughout the sequence and contains dark green or black

amphibolite bands. These bands are mostly concordant and range from 70 cm to several metres in thickness. The wider amphibolite bands are commonly laminated, e.g., north shore of Birchy Cove, Northern Arm, containing a 2.5 cm wide banding defined by variations in hornblende content. A larger scale layering, 30 to 100 cm wide, appears to be developed locally and may reflect original compositional variations in a mafic tuff protolith. The wider bands commonly have medium to coarse grained centres of mostly hornblende and plagioclase with fine grained schistose margins; the coarse grain size may be a metamorphic recrystallization texture. Some of the amphibolites may have originated as dikes or sills since one band on the east side of Facheux Bay appears to slightly truncate primary laminae in adjacent pelite/semipelite. Also, a band on the west side of Facheux Bay shows increasing grain size towards the centre as well as 4 to 10 mm long plagioclase "phenocrysts". These observations, and the actual presence of laminated mafic tuffs, suggest that both intrusive and volcanic origins are probable.

Three areas of amphibolite are designated subunit 4a. Like some of the large concordant bands described above, all three areas exhibit laminated and schistose margins with medium to coarse grained centres. The northern amphibolite zone in Facheux Bay has a massive megacrystic core with laminated margins and concordant contacts; within the centre zone, hornblende crystals are 1 to 3 cm across and enclose much finer grained plagioclase. A 20 m wide black graphitic pelite band occurs within the amphibolite. Whether the pelite is a xenolith or interbedded material was not determined. The origin of these areas (4a) of amphibolite is not clear. The stratigraphic position of the southern zone in Facheux Bay is identical to that in Northern Arm with respect to the southern contact of Unit 4; this might suggest some stratigraphic control and these two areas may represent a single stratigraphic horizon. Amphibolite was also noted in approximately the same stratigraphic position in the intervening area, but the amount of exposure and the scale of mapping prevented a more detailed delineation.

Fine to coarse grained sandstone with minor interbedded pelite and amphibolite occur in two main bands approximately 100 to 150 m wide. These bands occur on either side of the synclinal axis in Facheux Bay with the southern one well exposed at Doughball Cove. Similar clastic rocks occur on the point south of Little Cuiller Bay and along the north shore of Goblin Bay in Northern Arm (Plate 13). Traverses in the area between Facheux Bay and Northern Arm suggest that the two clastic bands form continuous stratigraphic horizons but, again, the scale of mapping and amount of exposure prevented full delineation. Minor sandstone beds occur elsewhere in Unit 4.



Plate 13: *North dipping, well bedded sandstones on the overturned limb of the Northern Arm Syncline, Unit 4 of the Isle Galet Formation at Goblin Bay.*

The sandstones are light to dark gray weathering, thin to thick-bedded, fine to coarse grained, and well foliated. Conspicuous, 1 to 3 mm across, quartz and feldspar grains generally form outsize, matrix supported clasts in a fine to medium grained, feldspar-rich matrix; locally the larger quartz grains are translucent and have a blue hue. Lithic clasts consist of fine grained, white weathering felsic tuff and semipelite. Beds range from 3 to 50 cm in thickness and are commonly graded with sharp bases (Plate 14). Interbedded with the sandstone are laminated, 1 to 5 cm thick beds and lenses of siltstone and pelite. Also, one conglomerate outcrop containing 2 to 15 mm long felsic volcanic clasts occurs associated with sandstone in the inland area east of Facheux Bay. Locally, 5 to 20 m wide zones of black graphitic pelite and concordant amphibolite occur within the coarse grained clastic bands at Facheux Bay. The pelite zones also contain isolated 10 to 30 cm thick beds and lenses of sandstone. Amphibolite lenses in the Goblin Bay area are 0.5 to 4 cm wide and are concordant with the sandstone beds. Continuous over several metres, these lenses have diffuse, gradational boundaries with the adjacent sandy beds and are marked by an increase in porphyroblastic hornblende.

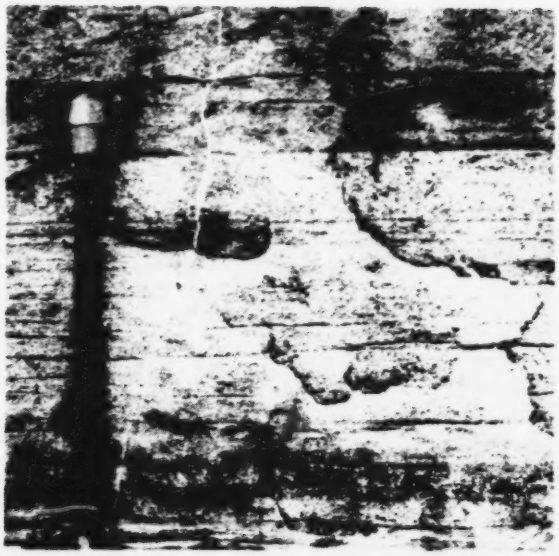


Plate 14: *Overturned graded sandstone bed on the overturned limb of the Northern Arm Syncline, Unit 4 of the Isle Galet Formation at Goblin Bay.*



Plate 15: *Quartzite bed in interbedded psammite and semipelite, Unit 4 of the Isle Galet Formation on Bois Island.*

Gray psammite and laminated semipelite beds, 0.5 to 20 cm thick, are locally interbedded with the black graphitic pelite. Semipelite at Ben Kent Head, Facheux Bay, contains 3 to 10 mm thick, pink weathering coticule bands that are generally strongly boudinaged. Also, a 12 cm thick white quartzite bed is interbedded with psammite and semipelite on Bois Island (Plate 15). The more pelitic rocks show a hornfels texture in the northern part of Unit 4 between Facheux Bay and Northern Arm, in the aureole of the North Bay Granite. Similar rocks are porphyroblastic in the Lampidoes Passage area where garnets up to 0.5 cm across overgrow the main foliation. Other porphyroblasts include 0.5 to 10 cm long, disoriented staurolite crystals, biotite books 0.4 mm across, and amphibole rosettes.

Narrow zones or lenses of fine grained felsic tuff also occur in Unit 4. These are several metres thick and one such zone persists along the contact between Units 3 and 4. On the point south of Birchy Cove, isoclinally folded tuffaceous beds are 4 to 12 cm thick with 2 to 5 mm wide laminae. Felsic tuff with distinct quartz phenoclasts also occur in the northern part of Unit 4 on the point south of Little Cuiller Bay in Northern Arm, and just north of Buffet Point in Facheux Bay. At Buffett Point, laminated, probable mafic tuff beds, 2 to 12 cm thick, are interbedded with the felsic material; amphibole rosettes are developed in the mafic beds. Concordant amphibolite bands also occur with bedded felsic tuff at Lampidoes Passage.

Petrography

The pelite and semipelite are dominated by well oriented biotite, chlorite, minor sericite and graphite which define the main foliation. This fabric is generally parallel to laminae in the semipelite which are defined by mica-rich bands alternating with quartz-rich bands. Near the southern contact of Unit 4, the quartz component consists of fine, slightly elongate, grains with diffuse, irregular boundaries. However, in the central and northern areas, a granoblastic to granoblastic polygonal texture predominates. Euhedral garnet and biotite porphyroblasts occur throughout, overgrowing the oriented micas; garnet also overgrows the biotite porphyroblasts. Locally, porphyroblastic muscovite and elongate cross-cutting crystals of chlorite are developed. In the northern part of the unit, including the Birchy Cove area of Northern Arm, large euhedral staurolite porphyroblasts occur with profuse garnet and biotite porphyroblasts. The staurolite and garnet overgrow S_1, locally with straight inclusion trails mostly of quartz. Tourmaline and zircon are accessory minerals in the pelite. The coticule bands

on the east side of Facheux Bay consists of approximately 60 percent euhedral and coalescing garnet with intercrystalline quartz and minor chlorite. Some of these garnets overgrow the boundaries between the coticule bands and the enclosing pelite/semipelite.

The concordant amphibolite bands contain 50 to 60 percent green hornblende, both as oriented and disoriented overprinting crystals. The hornblende is locally concentrated in laminae which alternate with partially polygonized quartz and altered plagioclase domains. Accessory magnetite also occurs. No significant quartz occurs in the probable porphyritic dike on the west side of Facheux Bay; the nearly completely altered plagioclase phenocrysts occur in a hornblende-plagioclase matrix.

The amphibolite (4a) at Ben Kent Head in Facheux Bay consists of green hornblende and plagioclase (An_{28}-An_{32}). The plagioclase is slightly sericitized and overgrown by the hornblende. Anhedral to subhedral magnetite overgrows the hornblende and plagioclase. Accessory minerals include biotite, chlorite and epidote. The amphibolite (4a) at Buffett Point in Facheux Bay has a crude banding on its contact defined by hornblende rich domains and plagioclase rich domains. Overgrowing hornblende rosettes are common. Toward the center of the body, coarse (1 to 4 mm long), simple-twinned plagioclase laths (An_{30}) are the same size as tabular hornblende crystals. The rims of the large hornblende crystals are recrystallized into fine grained acicular aggregates of hornblende. Skeletal magnetite containing biotite within the crystal outline is common. The megacrystic core of this amphibolite body has an ophitic texture with 1 to 3 cm long hornblende crystals enclosing plagioclase laths. The rims of the hornblende crystals are recrystallized and locally the plagioclase laths are recrystallized to polycrystalline aggregates. The amphibolite (4a) at Birchy Cove in Northern Arm, of probably mafic tuff origin, locally contains up to 40 percent plagioclase phenocrysts or clasts with minor quartz crystals in a fine grained quartzofeldspathic matrix. Oriented biotite is well developed and is overgrown by hornblende. Accessory minerals include carbonate and sphene with the latter forming elongate patches that overgrow biotite.

The sandstones in Unit 4 contain round to angular quartz and feldspar clasts. Quartz clasts occur as strained single crystals, as partially recrystallized crystals with subgrain boundary development, and as polycrystalline clasts. Feldspar clasts consist mostly of sericitized plagioclase but also include orthoclase and myrmekitic plagioclase. The matrix varies from quartz rich to plagioclase rich with diffuse grain boundaries; locally, distinct granoblastic patches are developed. Biotite occurs throughout the matrix and generally is oriented along the main foliation. Chlorite (after biotite), sericite and graphite also define S_1. Although granoblastic patches with an incipient polygonal texture occur in most of the sandstone thin sections, those from the northern part of Unit 4 in areas south of Little Cuiller Bay and at Goblin Bay are particularly recrystallized. The quartz clasts, for example, are polygonized polycrystalline grains that occur in a fine grained polygonized matrix. This produces the "sugary" texture observed in outcrop and preserves the original clastic texture. Biotite is locally polygonized with dimensionally oriented porphyroblasts mimicking the main foliation. Garnet and hornblende porphyroblasts also overgrow oriented biotite. Zircon, epidote, tourmaline, allanite, chlorite, sericite, garnet and hornblende occur in accessory proportions.

The mafic tuff bands contain up to 50 percent plagioclase clasts with minor quartz in a fine grained quartzofeldspathic matrix. Oriented and disoriented hornblende, chlorite and biotite, along with accessory carbonate and magnetite, occur throughout the matrix. Laminae in the felsic tuff are defined by quartz-rich layers that are coarser grained than biotite-rich, quartzofeldspathic layers. The matrix is equigranular and granoblastic in the northern area where garnet porphyroblasts overgrow oriented chlorite and sericite. Accessory minerals include epidote, chlorite and sphene.

Structure and Metamorphism

The main penetrative foliation developed throughout Unit 4 has moderate to steep northward dips in the east and steep to vertical dips in the west. It is a phyllitic to finely schistose fabric that locally has a strong flattening component, as shown by the augen structure formed by lithic and crystal clasts in the sandstone bands. This regional foliation is axial planar to small scale, tight to isoclinal, F_1 folds as well as the Northern Arm Syncline, whose axis is sited in the southern part of Unit 4 west of Northern Arm. The northern limb of the syncline is overturned in the Northern Arm - Goblin Bay area; it is a tight upright structure in the Facheux Bay area. The two sandstone bands that occur on either side of the fold axis in Facheux Bay probably represent a single stratigraphic horizon that is repeated by the syncline. Bedding/cleavage intersections on the southern limb indicate closure to the north; graded beds in the northern sandstone band consistently face

south. Overturned beds on the northern limb of the fold in the Northern Arm - Goblin Bay area also face south.

Boudins and pinch and swell structures developed locally during the first deformation. The thin coticule bands at Ben Kent Head have been strongly boudinaged with most long axes plunging 5° to the west. However, extension was not just confined perpendicular to this one direction within the boudin layers as some axes plunge 45° to 70° west.

A crenulation cleavage is preferentially developed in the more pelitic rocks of Unit 4. It generally has a trend parallel to the main foliation and, although some dips are gentle to moderate, most are steep to vertical. Only minor folding is associated with this cleavage in the central and western parts of Unit 4 but it is axial planar to a profusion of F_2 folds in the Goblin Bay - Lampidoes Passage area (Plate 16). The axial trace of these folds is subparallel to that of the large scale F_1 folds but the F_2 folds have considerably smaller wavelengths, of approximately 200 m or less in Goblin Bay. The plunge of the F_2 folds is gentle to moderate in a west or east direction. Where superimposed upon the overturned limb of the Northern Arm Syncline, a number of downward facing F_2 folds can be demonstrated in the graded sandstone beds. Both the sense of vergence of small scale, second order F_2 folds and grading in the sandstones combine to confirm a classic F_2 antiformal syncline in the Little Harbour area of Goblin Bay.



Plate 16: *Upright F_2 folds in graphitic pelite with a well developed axial planar crenulation cleavage, Unit 4 of the Isle Galet Formation at Goblin Bay.*

The main fabric in Unit 4, interpreted as the first foliation or S_1, is mostly defined by oriented biotite or oriented zones of biotite within which individual biotite crystals have been polygonized. This orientation is generally coplanar with bedding except in small scale F_1 fold hinges. However, as in Unit 1, there is a local mica orientation in laminated rocks of mostly pelitic composition that appears to predate the main foliation. This is best seen in a thin section of laminated pelite from east of Little Cuiller Bay where the main fabric (S_1) is parallel to laminae (S_0) and both S_0 and S_1 are overprinted at a high angle by an intense crenulation cleavage (S_2). Cross-oriented, polygonized, fine grained flakes of sericite and chlorite occur between the S_1 fabric planes: locally, these presumably earlier micas form a herringbone pattern. However, since there is no macroscopic evidence of folding predating the main regional folds and since this phenomenon mostly occurs in pelites, it is suggested that the apparently early micas represent a primary anisotropy of detrital clay minerals aligned parallel to bedding in original mudstones, and these were transposed by the first deformation and mimetically recrystallized by a synkinematic or later metamorphic event. Alternative explanations include layer parallel shear zones that could have developed during F_2 buckling (de Wit, 1976) and, of course, that the rocks have been affected by an earlier tectono-metamorphic event.

Metamorphic grade and textures in Unit 4, particularly in the northern part, are dominated by the contact metamorphic effects of the North Bay Granite (Unit 11). The micas (mostly biotite but including sericite and chlorite) defining S_1 are overgrown by euhedral biotite, garnet, hornblende and staurolite porphyroblasts that increase in size and profusion toward the large granite body. Straight S_1 inclusion trails are common in staurolite and garnet porphyroblasts. Granoblastic polygonal textures occur in both the matrix and clasts of sandstones, and crystals in quartz veins folded by F_1 locally have well developed triple junctions. Mimetically recrystallized micas along S_1 are also common. The crenulation cleavage or S_2 locally postdates the main period of porphyroblast development: garnet, hornblende and staurolite were all observed to occur as augen in the widely spaced S_2 cleavage planes (Plate 17). One hornblende porphyroblast in a mafic tuff had strain bands developed parallel to S_2 along which the crystal cleavage planes were slightly displaced. Sericite and graphite locally form new mineral growth along S_2.



Plate 17: *Photomicrograph of garnet augen in S_2 strain-slip cleavage. S_1 is transposed by S_2 which is defined by graphite and minor sericite. Unit 4 of the Isle Galet Formation at Buffett Point, Facheux Bay. Plane polarized light; field of view is 2.5 mm across.*

Contact Relationships

Unit 4 conformably overlies graphitic pelite of unit 3. A felsic tuff band several metres wide occurs in Unit 4 at or just above the contact. Unit 4 of the Isle Galet Formation is gradationally underlain along its northern boundary by Unit 5 of the Riches Island Formation.

Riches Island Formation (Unit 5)

Definition and Division

Colman-Sadd (1976) defined psammites and phyllites that occur north of the Isle Galet Formation as the Riches Island Formation. A conformable contact separates the two formations on Bois Island in both the St. Alban's (Colman-Sadd, 1976) and Gaultois (Colman-Sadd et al., 1979) map areas. These two formations have a similar relationship in the Facheux Bay map area where the Riches Island Formation forms the northernmost part of the Baie d'Espoir Group. An extensive intrusion breccia zone (subunit 11a) is developed along its northern boundary where the Riches Island Formation is intruded by the North Bay Granite (Unit 11). To the south, it stratigraphically *underlies* the upper part (Unit 4) of the Isle Galet Formation on the northern limb of the Northern Arm Syncline. It structurally underlies Unit 4 west of Northern Arm, but structurally overlies Unit 4 in the overturned area east of Northern Arm. This stratigraphic and structural relationship of having the Riches Island Formation on the northern limb of the syncline, and part of the Isle Galet Formation on the southern limb, suggests that the formations are, in part, lateral time-stratigraphic equivalents. Thus, the Stanley Cove Member probably pinches out down dip into the Riches Island Formation with the upper part of the Isle Galet Formation (Unit 4) overlying both successions. The Riches Island Formation contrasts with the Isle Galet Formation in the Facheux Bay map area by being largely a bedded psammite, laminated semipelite sequence with only minor amounts of the felsic tuff, black graphitic pelite, and amphibolite characteristic of the Isle Galet Formation.

Distribution

The Riches Island Formation in the Facheux Bay map area (11P/9) has its greatest outcrop width of 2.5 km between Northern Arm and Lampidoes Passage, where it either extends to the northern boundary of the map area or is limited by the North Bay Granite. West of Northern Arm, it forms a fairly regular 0.8 to 1.0 km wide belt that is cut off on both ends by the intrusion breccia zone (subunit 11a).

Description

The dominant rock types of the Riches Island Formation are strongly foliated, light gray pelite/semipelite and psammite. The pelite and semipelite form 1 to 10 cm thick beds that are commonly laminated: laminae are 1 to 10 mm thick and defined by slight variations in color. In some areas, compositional variations are accentuated by the preferential growth of biotite or garnet porphyroblasts in particular laminae. Locally, quartz segregations of regular 1 to 4 mm width are concordant with primary layering in semipelite, adjacent to the intrusion breccia zone. Very minor black graphitic pelite occurs in the Riches Island Formation in the Facheux Bay area but several outcrops of black graphitic argillite were noted in the north-central area east of Northern Arm. Coticules also occur in this eastern area forming isolated 2 to 10 cm bands parallel to laminae in the pelite/semipelite. All these rocks are generally dominated by profuse porphyroblast development (Plate 18) associated with the aureole of the North Bay Granite: garnet, biotite and muscovite porphyroblasts are up to 4 mm across, staurolite up to 2 cm long, and hornblende forms disoriented crystals and rosettes.

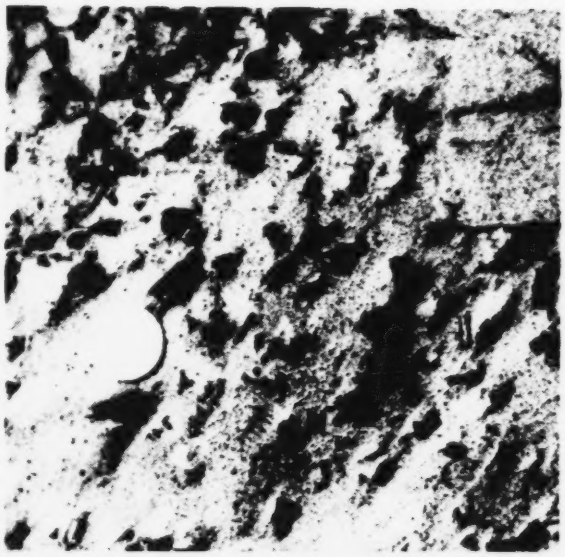


Plate 18: *Staurolite porphyroblasts in pelite/semipelite, Riches Island Formation (Unit 5), just south of Allan Cove, Facheux Bay.*



Plate 19: *Bedded psammite with thin pelitic interbeds, Riches Island Formation (Unit 5) at Allan Cove, Facheux Bay.*

Psammite beds are 5 to 50 cm thick (Plate 19) in psammite dominated zones, with minor 1 to 10 cm interbeds of pelite and semipelite, e.g., Allan Cove in Facheux Bay. However, thinner beds of psammite, 1 to 3 cm thick, occur where psammite is regularly interbedded with 4 to 10 cm thick beds of semipelite, such as the area south of Raymond Passage in Northern Arm. Associated with the psammite beds in the East Bay area of Northern Arm are white weathering, 4 to 25 cm thick beds of quartzite and 10 to 50 cm thick beds of feldspathic quartzite. Some of the quartzite beds are micaceous.

Minor sandstone beds of quartz and feldspar, with some pelitic intraclasts, occur in the Riches Island Formation near its contact with the Isle Galet Formation at Facheux Bay. The sandstone is fine to coarse grained and forms 5 to 40 cm thick, graded, southward facing beds that have laminated (2 to 8 mm), fine grained tops. Commonly the sandstone beds are capped by pelite that is 0.5 to 1 cm thick. These cyclic beds are interpreted as partial Bouma sequences with the coarse grained bottom portion of a sandstone bed corresponding to division A, the laminated top to division B and the thin pelitic cap to division E, or to normal pelagic deposition. Thin, concordant lenses of amphibolite occur locally in the sandstone similar to that described in Unit 4 sandstones of the Isle Galet Formation. The only other noted occurrence of amphibolite in the Riches Island Formation was on its southern contact west of Lampidoes Passage, where minor 0.5 to 4 cm thick beds of amphibolite occur in semipelite.

Leucocratic granite veins are common in the Riches Island Formation adjacent to the North Bay Granite intrusion breccia zone (subunit 11a). The veins locally contain garnet and/or tourmaline, are concordant and cross-cutting, and are either foliated or unfoliated.

Petrography

All of the rocks of the Riches Island Formation are dominated texturally by the contact metamorphic effects of the North Bay Granite. Laminae in the pelite and semipelite consists of mica-rich layers which alternate with quartz-rich layers. The micas commonly consist of polygonized flakes of biotite, muscovite and chlorite that have mimetically recrystallized along bedding or the two foliation planes. The quartz component exhibits granoblastic elongate to incipient polygonal textures that locally culminate in a granoblastic network of quartz crystals with classic triple junctions (Plate 20). Mostly euhedral porphyroblasts of staurolite, biotite and garnet overgrow the earlier micas; garnet forms euhedral crystals within staurolite and overgrows the margins of



Plate 20: *Photomicrograph of polygonized quartz with straight boundaries and triple junctions in semipelite. Riches Island Formation (Unit 5) at Allan Cove, Facheux Bay. Cross polarized light; field of view is 0.4 mm across.*

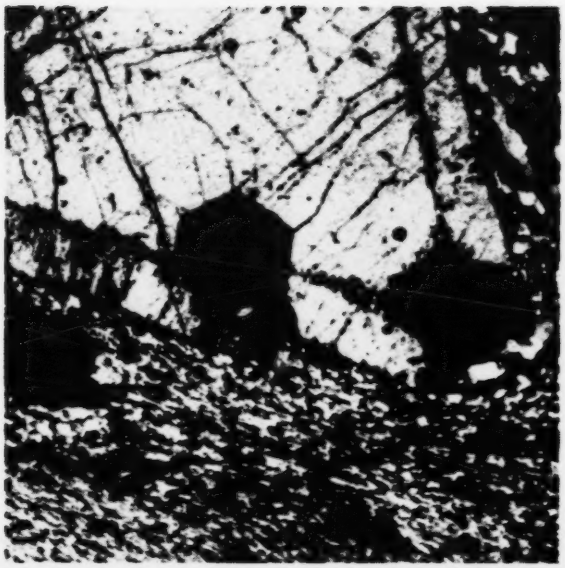


Plate 21: *Photomicrograph of euhedral garnet and staurolite porphyroblasts overgrowing main foliation (S_1) in semipelite. Riches Island Formation (Unit 5) at Allan Cove, Facheux Bay. Cross polarized light; field of view is 2.5 mm across.*

staurolite and biotite crystals (Plate 21). Quartz inclusion trails are common in the garnet and staurolite porphyroblasts. Garnet also occurs as elongate coalescing patches that include matrix quartz. Staurolite, and rarely garnet, locally form augen structures in the first foliation and second fabric planes. However, they also commonly overgrow the microcrenulations associated with S_2 as well as micas oriented along the second fabric. Chlorite forms large rectangular shaped porphyroblasts, and also occurs as an alteration of biotite and, rarely, staurolite. Accessory tourmaline occurs locally.

The sandstones consist mostly of polycrystalline quartz and recrystallized plagioclase clasts that are surrounded by a granoblastic to granoblastic polygonal, quartzofeldspathic matrix. Oriented to disoriented biotite and sericite are overgrown by garnet porphyroblasts. Tourmaline, opaque minerals and zircon are accessory minerals.

The psammite and quartzite also exhibit granoblastic polygonal textures. Thin, micaceous laminae contain polygonized muscovite which form an overprinting herringbone pattern. In the quartzites, single crystals of mica have grown along quartz grain boundaries that form triple junctions, and appear to be controlled in size and orientation by the recrystallized matrix. The coticule bands consist of subhedral to euhedral garnet (approximately 50 percent) and granoblastic quartz. The garnets are mostly restricted to the coticule bands but locally overgrow the boundaries with the enclosing pelite (Plate 22).

Structure and Metamorphism

The first foliation (S_1) in the Riches Island Formation is nearly everywhere parallel to bedding except in the hinges of small scale isoclinal F_1 folds. It is generally steeply dipping and parallel to the regional structural grain. S_1 varies from a fine grained schistosity in the southern parts of the formation to a medium grained schistosity with proximity to the intrusion breccia zone; mimetically recrystallized biotite and muscovite and thin segregations of quartz outline the first fabric adjacent to the intrusion breccia (11a).

The second foliation (S_2) is developed throughout the Riches Island Formation, is either vertical or steeply dipping, and its strike is regionally subparallel to the

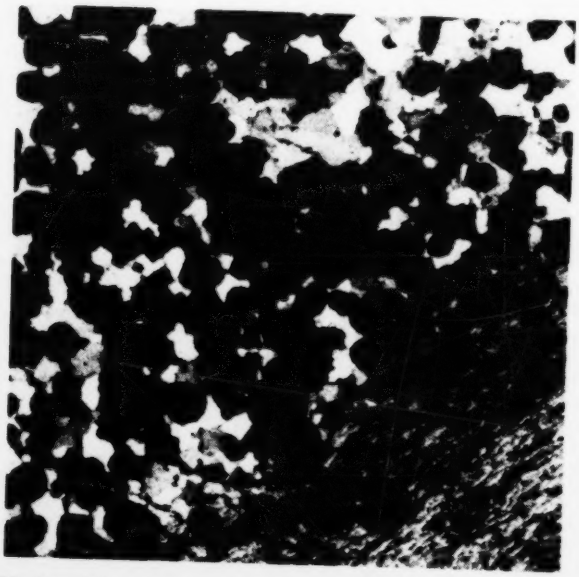


Plate 22: *Photomicrograph of subhedral to euhedral garnet and granoblastic quartz in a coticule band. Riches Island Formation (Unit 5) north of Goblin Bay. Cross polarized light; field of view is 2.5 mm across.*



Plate 23: *S_2 crenulation cleavage in hinge of F_2 fold in laminated semipelites, Riches Island Formation (Unit 5) south of Raymond Island.*

trend of the first fabric. Locally, it has resulted in renewed flattening along S_1, but most commonly it is axial planar to a profusion of crenulations (Plate 23) and open F_2 folds: rarely the F_2 folds are tight. S_2 becomes the main foliation in the Riches Island Formation adjacent to the intrusion breccia zone. It is a penetrative, composite fabric in pelite and semipelite, defined by fine to medium grained biotite and muscovite near the North Bay Granite (Unit 11) contact at East Bay and Raymond Passage. In this area there is little evidence of the earlier foliation because of complete transposition along S_2, and recrystallization associated with the North Bay Granite. However, initial impressions of S_2 being the first and only fabric in this area are convincingly refuted in the cliff face south of Raymond Passage where the well developed, steeply dipping, second foliation is superimposed upon both limbs of relatively large scale F_1 folds that are overturned to the south (Plate 24).

Staurolite and garnet porphyroblasts generally overgrow pre-existing fabrics, including S_2, in the Riches Island Formation. Where this occurs, the inclusion trails (Si) are straight and parallel to the external foliation (Se). Inclusion trails in porphyroblasts that form augen



Plate 24: *Both limbs of an overturned, southward facing F_1 fold are overprinted by the vertical S_2 crenulation cleavage (parallel to gaff handle) in interbedded psammites and semipelites, Riches Island Formation (Unit 5) south of Raymond Island.*

structures in S_2 are also straight, but Si forms various angles with Se. Locally, single staurolite or garnet porphyroblasts overgrow micro-intrafolial F_1 folds defined by biotite and muscovite, are wrapped around by oriented biotite and muscovite defining S_2, and have projecting lobes that overprint S_2 as well. Reflattening along S_1 during development of S_2 is demonstrated by perfectly euhedral staurolite crystals that have sharply overgrown the bedding parallel first fabric but, at opposite ends of the porphyroblast, in a direction perpendicular to the foliation, oriented micas are deflected around the crystal outline. Most commonly, in rocks adjacent to the North Bay Granite, porphyroblasts of biotite, garnet and staurolite overgrow oriented polygonized biotite and muscovite that have mimetically recrystallized along S_2. Where the second deformation is manifested by a profusion of microcrenulations, inclusion trails in overprinting staurolite reflect the microfolds. Micas outlining the crenulations are also polygonized.

The second foliation is generally more pronounced in the Riches Island Formation than in the Isle Galet Formation. Rarely does new mineral growth occur along the S_2 crenulation or strain-slip cleavage in the latter. Also, porphyroblasts related to the North Bay Granite mostly predate the second crenulation cleavage in the Isle Galet Formation. Although a similar relative chronology occurs locally in the Riches Island Formation, most of the peak metamorphism occurred during or after the second deformation in rocks adjacent to the granite. This, of course, is consistent with temperatures being higher for a longer period of time in the Riches Island Formation closest to the North Bay Granite.

Contact Relationships

The Riches Island Formation along its southern contact conformably underlies Unit 4 of the Isle Galet Formation. The contact itself is marked everywhere in the map area by thinly bedded and laminated semipelite that is richly porphyroblastic. Minor sandstone beds in the southern part of the formation at Facheux Bay are quite similar to sandstone in Unit 4, reflecting the gradational nature of the two units.

The northern boundary of the Riches Island Formation is defined at an intrusion breccia zone consisting of North Bay Granite and metasedimentary rocks of the Riches Island Formation. The contact is relatively abrupt and is marked by the first significant occurrence of granite that is usually continuous over several hundreds of metres. Granite veining in the Riches Island Formation is restricted to the area adjacent to the intrusion breccia zone. Most of the veins are concordant and weakly to strongly foliated; rarely veins are folded. Some veins locally truncate small-scale F_1 fold limbs, yet contain a foliation parallel to the F_1 axial planar fabric (Plate 25). This could indicate that the veins are late synkinematic with respect to S_1 or that renewed flattening occurred along S_1 during intrusion of the North Bay Granite. Granite veins of the same composition are also unfoliated and cut across the main fabric(s) in the country rocks. These relationships are interpreted to mean that granite intrusion was largely a post D_1 event.



Plate 25: *A leucogranite vein related to the North Bay Granite (Unit 11) truncates a F_1 fold limb in the Riches Island Formation (Unit 5); a weak fabric in the vein is parallel to the axial planar fabric (S_1) in the fold hinge, along the contact between the Riches Island Formation and the North Bay Granite at Allan Cove, Facheux Bay.*

Little Passage Gneiss (Unit 6)

Definition and Division

High grade metamorphic rocks that occur south of the Isle Galet Formation on Long Island were originally included as a conformable part of the Ordovician Baie d'Espoir Group (Jewell, 1939; Anderson, 1967). Colman-Sadd (1974), however, interpreted these rocks as a basement gneiss complex to the Baie d'Espoir Group; hence, they were separated from the group and named the Little Passage Gneiss. The age of the Little Passage Gneiss was considered to be certainly pre-Ordovician and possibly

Precambrian (Colman-Sadd, 1976, 1980b). A tectonic contact called the Day Cove Thrust was said to separate the Little Passqe Gneiss from the overlying Ordovician cover rocks (or redefined Baie d'Espoir Group). Structures in the Baie d'Espoir Group were described as reworking older structures in the gneissic basement, culminating in intensity along the Day Cove Thrust.

In this report, rocks defined as the Little Passage Gneiss have been re-instated as part of the Baie d'Espoir Group. As discussed below, no fundamental break occurs between these metamorphic rocks and the rest of the Baie d'Espoir Group in the Facheux Bay (11P/9) map area: structural, metamorphic and, to some extent, lithic continuity can be traced across the previously assigned basement/cover contact. The name "Little Passage Gneiss" is retained for the amphibolite facies psammitic and semipelitic metasedimentary rocks which also contain profuse concordant leucogranite veins and remobilized zones of migmatite. The locally complex metamorphic and igneous character of the Little Passage Gneiss makes it difficult to everywhere determine its exact stratigraphic position in the Baie d'Espoir Group; it is therefore defined as a lithodemic unit within the group. A small area along the northeast shore of Long Island has far less leucogranite veining and metamorphic remobilization than the rest of the Little Passage Gneiss, and is designated subunit 6a.

The Little Passage Gneiss is generally in contact along its northern boundary with felsic volcanic rocks of the Stanley Cove Member, on the overturned limb of the Manuel Arm Anticline. It everywhere structurally underlies the member but is interpreted in part to stratigraphically overlie the felsic volcanic rocks. The Little Passage Gneiss is intruded along its southern boundary by the McCallum Granite. This granite controls the outcrop width of the Little Passage Gneiss such that only a very narrow band of the gneiss exists between Facheux Bay and Manuel Arm where the granite is of greatest extent. West of Facheux Bay, beyond the western limit of the Isle Galet Formation, the Little Passage Gneiss is bounded by the McCallum Granite in the south and the intrusion breccia zone related to the North Bay Granite in the north.

Distribution

The Little Passage Gneiss forms a linear outcrop belt of variable width throughout the Facheux Bay map area. It is approximately 3.5 km wide in the central part of Long Island but varies from 0.2 to 0.8 km between Manuel Arm and Facheux Bay. It widens again west of Facheux Bay to a maximum of 3.9 km at the western limit of the Isle Galet and Riches Island Formations. Finally, it narrows to 1.6 km along the western boundary of the map area, as the McCallum and North Bay Granites converge.

Description

The Little Passage Gneiss generally consists of pelitic, semipelitic and psammitic schists which locally contain concordant quartz and granitoid segregations and injections, imparting a crudely gneissic character to the rocks. A profusion of concordant leucocratic granite veins occur everywhere and locally exceed 50 percent of the total volume. The metasedimentary rocks are mostly fine to medium grained, biotite-muscovite schists which commonly have a very regular layering that varies from 0.4 to 8 cm in width, like the exposures on Great Jervis Island and Long Island. The pelite, semipelite and psammite are also generally laminated with 1 to 2 mm compositional laminae. The layering on every scale is marked by diffuse gradational boundaries, generally between psammitic and semipelitic layers of varying widths; porphyroblastic mica commonly accentuates the less psammitic layers (Plate 26). Therefore this structure is interpreted as primary in origin, being not too different in scale and type from interbedded psammite and semipelite in the Isle Galet and Riches Island formations; the



Plate 26: ***Interbedded psammite and semipelite with muscovite porphyroblasts accentuating the more pelitic beds, Unit 6 of the Little Passage Gneiss on the north shore of Great Jervis Island.***

pronounced mica schistosity is generally coplanar to these bedding surfaces. Disoriented muscovite and biotite porphyroblasts, 2 to 10 mm across, are ubiquitous with muscovite being the more common and coarser grained. Garnet porphyroblasts, 1 to 4 mm in diameter, and tourmaline crystals up to 1 cm long are locally developed in the more pelitic rocks. Narrow bands of amphibolite with 0.5 to 3 cm wide laminae are interlayered with the micaceous metasedimentary rocks in some areas: hornblende is oriented to disoriented in these zones and also forms overprinting porphyroblasts in the pelitic and psammitic rocks. The psammitic beds and the quartzofeldspathic component of the pelitic beds have been generally recrystallized to an approximately equigranular, crystalline texture, becoming coarser grained with proximity to the McCallum Granite. This produces a fine grained "sugary" texture in psammite along the northern boundary of the Little Passage Gneiss and imparts a superficial granitoid appearance to semipelite adjacent to the McCallum Granite where the mica rich rock contains distinct, recrystallized domains, 1 to 2 mm across, of quartz and feldspar.

Leucocratic granite aplite and pegmatite veins, commonly containing garnet and tourmaline, are ubiquitous in the Little Passage Gneiss. They are most widespread in the vicinity of the McCallum Granite contact such that they consistently represent up to 50 percent or more of the outcrop area between Great Jervis Island and Facheux Bay. For the most part, the veins are concordant to the primary layering and range from 1 cm to 2 m in width, which approximately corresponds to the width of the intervening metasedimentary host rocks. The regular, concordant nature of the leucogranite veins is strikingly displayed in the cliff face on the south side of Great Jervis Island where, from a distance, the gently dipping grayish white weathering veins look like beds (Plate 27). An intense foliation, generally containing a pronounced mineral augen, is common in the granite veins and is mostly coplanar with the main fabric in the metasedimentary rocks. Equigranular to feldspar porphyritic, biotite granite veins similar to the McCallum Granite also locally intrude the metasedimentary rocks.

The metasedimentary zones between the granite veins commonly contain a profusion of quartz and granitoid segregations (Plate 28), particularly in the southern parts of the Little Passage Gneiss, including most of the area between Manuel Arm and Facheux Bay. The quartz and granitoid material occurs in mostly concordant lenses and welts, 0.5 to 2 cm wide, some of which originated *in situ*; others were clearly injected into the metasedimentary host.



Plate 27: *Concordant leucogranite veins and lenses are parallel to the regional foliation in high grade metasedimentary rocks, Unit 6 of the Little Passage Gneiss on the south shore of Great Jervis Island.*



Plate 28: *Quartz and granitoid segregations and injections are developed parallel to primary layering and the S_1 foliation in psammite and semipelite, Unit 6 of the Little Passage Gneiss near its southern contact on Long Island.*

Individual quartz augen and quartz-feldspar augen have also developed. Where well developed, this igneous component, combined with the recrystallization of the host rock, gives the largely pelitic and psammitic schists a distinct migmatitic aspect (Plate 29). Locally, pelitic xenoliths in the larger leucogranite veins are partially assimilated such that a wispy outline of biotite-rich schlieren is all that remains of the original rock. The most widespread development of migmatite occurs west of Facheux Bay, in the southern and central part of the area between the McCallum and North Bay granites and also south of the Isle Galet Formation in that area. The metasedimentary protolith is riddled with quartz and granite stringers and locally forms discrete xenoliths and rafts in a poorly banded granitoid. The crude banding in the granitoid is defined by discontinuous biotite concentrations, up to 0.5 mm wide, that occur along the penetrative fabric planes and form an oriented, anastomosing weave with intervening 2 to 5 mm wide quartzofeldspathic lenses. It is still possible to recognize primary layering in some of the larger inclusions within this migma, particularly where thin (0.5 to 4 cm) interbeds of psammite and semipelite are accentuated by differential erosion. The migmatitic aspect of these rocks, as well as the degree of recrystallization, decreases away from the McCallum Granite west of Facheux Bay. Migma is not well developed and coherent metasedimentary rocks predominate adjacent to felsic tuffs of the Stanley Cove Member; leucogranite veining, however, persists. At the northwestern end of the Isle Galet Formation (shown on the map as interfingering with the Little Passage Gneiss), graphitic pelite, psammite and amphibolite, intruded by garnetiferous leucogranite veins and biotite-rich granite veins, are included in the Little Passage Gneiss but quite clearly represent granite-riddled rock types of the Isle Galet Formation. Possible felsic volcanic rocks also occur in the Little Passage Gneiss on the coast in Facheux Bay and at Bonne Bay, within metres of the contact with the Stanley Cove Member. These occur as narrow, white weathering bands of fine grained, equigranular, quartzofeldspathic material that is locally laminated. Biotite exceeds muscovite in these zones and the rock is commonly garnetiferous. Although superficially similar to garnetiferous granite aplite veins, the much higher proportion of biotite, the fine equigranular texture, and the local presence of laminae all serve to distinguish these bands from the granite veins at these localities.

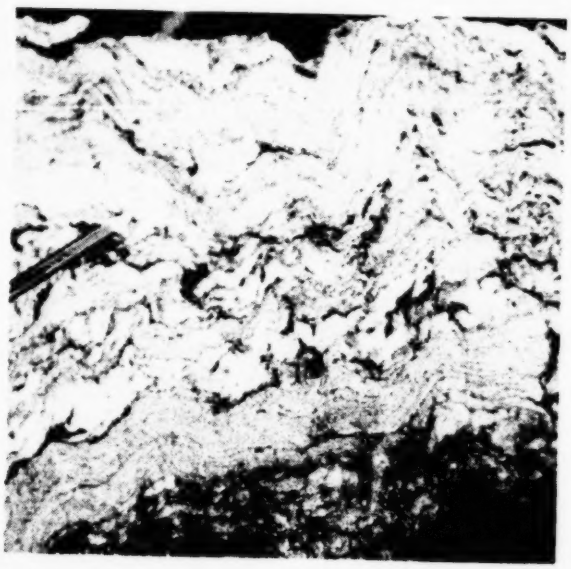


Plate 29: *Migmatite consisting of recrystallized psammite with profuse quartz and granitoid segregations, Unit 6 of the Little Passage Gneiss on the west side of Bonne Bay.*

The section through the Little Passage Gneiss on Long Island best demonstrates the tectonometamorphic variations within the lithodeme. Elsewhere, the influence of the McCallum Granite, or the McCallum and North Bay granites together, masks these internal variations. Along its southern contact with the McCallum Granite on Long Island, the Little Passage Gneiss consists equally of concordant leucogranite veins and intervening metasedimentary rocks. Quartz segregations and granite sweats occur in the compositionally banded, fine grained, gray to black weathering semipelite and psammite. Locally, profuse plagioclase porphyroblasts up to 1 cm long have overgrown and nearly obliterated layering (Plate 30) in pelitic to psammitic schists around the eastern boundary of the map area. There is, however, a marked decrease in the migmatitic aspect of these rocks that occurs concomitantly with a decrease in the amount of leucogranite veining away from the McCallum Granite. This is well displayed at the western end of Long Island between the southern contact of unit 6 and Green Point. At Green Point, regularly layered psammite and semipelite with only minor quartz and granite segregations form 4 to 8 cm thick, laminated beds; leucogranite veining has decreased to approximately 30 percent by volume. Eastward, along the north shore of Long Island, at Green Point Cove, Lobscouse Cove and Butter Cove, the Little Passage Gneiss essentially comprises well layered pelitic to psammitic schists, minor concordant amphibolite and, apart from unit 10, subordinate leucogranite. Here, again, the regular layers of 0.5 to 8 cm width, defined by gradational

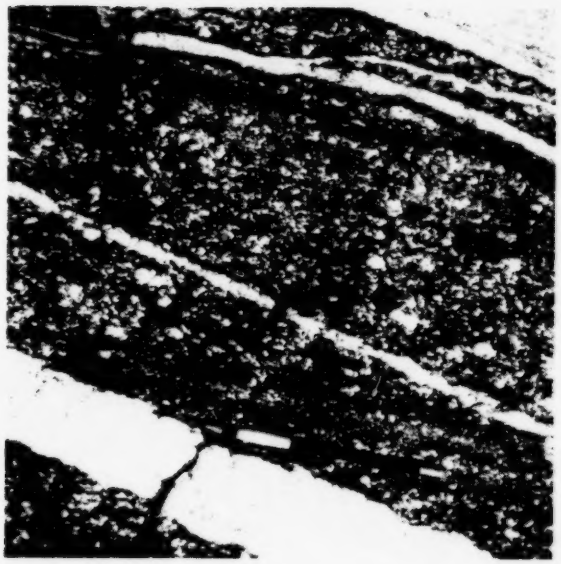


Plate 30: *Plagioclase porphyroblasts nearly obliterate compositional layering in pelitic to psammitic schists, Unit 6 of the Little Passage Gneiss near its southeastern contact with the Gaultois Granite on Long Island.*



Plate 31: *Interbedded psammitic and semipelitic schists, Unit 6 of the Little Passage Gneiss on the north shore of Long Island.*

boundaries between usually thicker psammitic layers and thinner pelitic layers (Plate 31), are interpreted as primary.

The structural top of the Little Passage Gneiss is marked by a 300 m wide zone of nearly granite free metasedimentary rocks east of Butter Cove. Designated subunit 6a, it is mostly this lack of significant granite veining that distinguishes it from the rest of Unit 6. However, one 60 cm wide pegmatite was noted as well as minor 0.2 to 10 cm thick sheets and lenses of garnetiferous aplite. Otherwise subunit 6a consists of 4 to 10 cm thick, laminated beds of psammite, semipelite, pelite and amphibolite that are dark gray, dark green or black weathering. Fine grained muscovite and biotite define a bedding parallel foliation; muscovite, garnet and hornblende porphyroblasts occur locally. Some of the more feldspathic rocks may have had a volcaniclastic origin since local occurrences of quartz and feldspar augen, 1 to 3 mm across, look quite similar to phenoclasts in tuffaceous beds within the Isle Galet Formation. Also, 25 cm wide bands of light weathering, fine grained, siliceous material, of probable felsic volcanic origin, occur interlayered with black pelite on the eastern side of Clay Hole, adjacent to felsic tuffs of the Stanley Cove Member. One outcrop of black graphitic pelite was observed on the beach on the Clay Hole side of the narrow neck between Clay Hole and Patrick Harbour, near or on the contact between the Little Passage Gneiss and the Stanley Cove Member of the Isle Galet Formation.

Petrography

Primary layering in the pelitic to psammitic schists is defined by variations in grain size and composition. Generally biotite and muscovite rich layers alternate with quartzofeldspathic layers. However, quartz rich bands also alternate with plagioclase rich bands, and the feldspar is commonly coarser grained. The quartz and feldspar locally form equant grains with straight to curved grain boundaries, but interlocking, sutured grains showing undulous extinction and strong development of sub-grain boundaries also occur, e.g., Great Jervis Harbour. Locally, plagioclase is strongly saussuritized but suitably oriented fresh grains indicated compositions of An_{18} - An_{38}. Biotite and muscovite occur in varying proportions in the pelite and pelitic laminae within the more feldspathic schists. For the most part, the micas form distinct, overlapping, tabular crystals, as opposed to a felted mat, that are strongly oriented along the laminae and/or the main foliation. Locally, musco-

vite porphyroblasts form large spindle-shaped augen or occur as late, overgrowing, euhedral crystals. Porphyroblastic biotite also overgrows the oriented micas. Other porphyroblasts which are preferentially developed in the pelitic component of these schists include garnet, plagioclase, tourmaline and hornblende. These mostly overgrow the oriented micas with the amphibole locally occurring in clusters of disoriented crystals. Some garnets contain quartz and mica inclusions that are finer grained than the matrix. Large plagioclase porphyroblasts of An_{25} - An_{40} composition also contain quartz, biotite and chlorite inclusions. Chlorite is everywhere variably developed after biotite. Accessory minerals in the schists include carbonate, euhedral apatite, epidote, cordierite, zircon and sphene. A possible felsic volcanic band at Bonne Bay consists of granoblastic quartz and lesser plagioclase with minor microcline. Rare garnets in this band contain quartz inclusions that are finer grained than the surrounding matrix; oriented muscovite and biotite are equally developed.

The same mineralogy dominates in the migmatized version of the metasedimentary protolith. However, mineral grains are coarser and the granitoid component is more widespread. The granitoid commonly forms elliptical domains of plagioclase ± orthoclase and sutured to granoblastic quartz; minor mica and myrmekite also occur within these granodiorite to tonalite sweats and/or injections. The granitoid domains are surrounded by strongly oriented biotite and much finer grained, locally elongate, quartzofeldspathic material; earlier mica orientations preserve intrafolial folds in these zones. Biotite, variably altered to chlorite, is the dominant mica in the migmatites but muscovite porphyroblasts are common. Other porphyroblasts include garnet, plagioclase, and tourmaline. Accessory minerals include sphene, zircon, and euhedral to subhedral apatite which overgrows biotite.

Concordant amphibolite bands comprise about 50 percent hornblende; the remainder is plagioclase and quartz in approximately equal amounts. The plagioclase is locally sericitized but compositions of An_{45} - An_{50} were determined. Accessory minerals include biotite and sphene.

Sericitized, myrmekitic plagioclase exceeds orthoclase and microcline in the leucogranite veins. The plagioclase locally contains inclusions of microcline. Quartz occurs as slightly elongate polycrystalline domains between the feldspar. Muscovite exceeds biotite and together they define the penetrative foliation. Large muscovite flakes also form augen in the foliation planes. Apatite and chlorite (after biotite) are accessory minerals.

Micas in pelite and semipelite of subunit 6a form a strongly oriented, interwoven mat. Muscovite exceeds biotite and some of the latter is altered to chlorite. Quartz predominates in the quartzofeldspathic domains and quartz also forms individual grains throughout the pelitic bands. Accessory tourmaline overgrows the micas. The probable felsic tuff band at Clay Hole consists mostly of granoblastic quartz, some plagioclase and minor fine grained, oriented, biotite and chlorite: carbonate, apatite and muscovite are accessory minerals.

Structure and Metamorphism

The first and main penetrative foliation in the Little Passage Gneiss is a fine to medium grained schistosity. It has, for the most part, a westerly trend and a gentle to moderate northerly dip; the strike is northwest in the Great Jervis Harbour area and some dips are steep west of Facheux Bay. The schistosity is generally coplanar to bedding in the metasedimentary rocks and parallel to the crude migmatitic banding in their higher grade equivalents. Locally it is axial planar to small scale F_1 isoclinal folds of both types of layering. These folds are overturned to the south, and along the north shore of Long Island, at Green Point Cove for example, the sense of vergence of small-scale F_1 z-folds indicates that these rocks are on the bottom limb of the overturned Manuel Arm Anticline (Plate 32). Also, the penetrative S_1 fabric has a shallower dip than primary layering at both Green Point Cove and Lobscouse Cove, further confirming the overall structural position of the Little Passage Gneiss on the overturned limb.

S_1 is also strongly developed in the concordant leucogranite veins and commonly contains mineral (feldspar and/or quartz) augen. Locally it is displayed as a pronounced parting and overall it is parallel to the main foliation in the intervening metamorphic rocks. Although leucogranite veins locally truncate fold limbs of primary layering in the schists and migmatites, the main fabric is axial planar to preserved F_1 fold hinges suggesting that the granite veins are synkinematic. Also, some veins are folded with the metasedimentary rocks around F_1 folds. S_1 has a cataclastic component in migmatites and metasedimentary rocks west of Facheux Bay; a pronounced augen structure is developed locally in the crudely banded granitoid.

A crenulation or strain slip cleavage is superimposed upon the main foliation in some parts of the Little Passage Gneiss. It is largely axial planar to open and tight folds which produce interference patterns in some areas.



Plate 32: *F_1 Z-fold in bedded psammite and semipelite, looking westward on the overturned limb of the Manuel Arm Anticline; S_1 is parallel to bedding except in the fold hinge where it is axial planar, Unit 6 of the Little Passage Gneiss at Green Point Cove on Long Island.*

Biotite and muscovite define the main fabric in the schists. The micas are also oriented and parallel to granitoid sweats and/or injections which define the crude gneissic banding in the migmatites. Garnet porphyroblasts both overgrow S_1 and form augen in the main fabric planes; hornblende porphyroblasts mostly overgrow the foliation. Plagioclase porphyroblasts are selectively developed in pelitic zones within the migmatites. These porphyroblasts overgrow the boundaries between compositional layering in the pelite and semipelite. The peak of metamorphism appears synkinematic with respect to the main penetrative foliation since oriented micas, as well as granitoid and quartz segregations, mostly occur within the main fabric planes. However, garnet augen in the metasedimentary rocks and folded granitoid sweats in the migmatites suggest that the onset of metamorphism, including some partial melting, predated the development of the regional fabric and associated folds. The degree of migmatization increases southward in the Little Passage Gneiss, marked by a corresponding increase in the amount of leucogranite veining. Both of these features appear to culminate along the contact with the McCallum Granite.

Contact Relationships

The internal contact within the Little Passage Gneiss between Unit 6 and subunit 6a is based almost entirely upon the near disappearance of leucogranite veining in subunit 6a, which also represents the structural top of the Little Passage Gneiss on Long Island. Also subunit 6a is not as coarsely recrystallized as schists just south of the contact.

The boundary between the Little Passage Gneiss and the Stanley Cove Member (Unit 2) is not exposed on Long Island. It was originally interpreted as a major thrust fault called the Day Cove Thrust (Colman-Sadd, 1974) that was drawn along a topographic depression that occurs between the two units. One outcrop of black graphitic pelite was found in this topographic low, on the neck between Clay Hole and Patrick Harbour, a few metres structurally below the Stanley Cove Member. A zone of this graphitic pelite would explain the topographic low and also probably would have localized some fault movement between the two rather more competent units, particularly on the overturned, attenuated limb of the Manuel Arm Anticline. However there is no evidence of thrusting of the magnitude and fundamental nature postulated for the Day Cove Thrust. In fact, the presence of felsic tuff bands, black graphitic pelite, semipelite and psammite concordantly and structurally below the Stanley Cove Member suggests that they are part of a conformable sequence, in the way that similar (or the same) rocks sit above the Stanley Cove Member on the normal limb of the anticline. Also, the same penetrative foliation forms the first fabric in both units in the contact area and both units have undergone the same degree of metamorphism, i.e., biotite-muscovite fabric and garnet porphyroblasts. Even accepting the likelihood of some local differential movement between the Stanley Cove Member and the Little Passage Gneiss along a graphitic pelite zone, the two units on Long Island are essentially a conformable sequence.

The contact between the Stanley Cove Member and the Little Passage Gneiss between Manuel Arm and Facheux Bay is camouflaged by the intrusion of garnetiferous leucogranite veins. However the two units are concordant and have undergone the same style of deformation and degree of metamorphism. Also, possible felsic volcanic and graphitic pelite bands in the Little Passage Gneiss, close to the contact with the Stanley Cove Member at Bonne Bay and Facheux Bay, support the overall conformity of the two.

The Little Passage Gneiss is intruded along its southern boundary by the McCallum Granite. The contact follows the regional structural trend except for the Great Jervis Harbour area where it trends southeast; structures in the Little Passage Gneiss diverge from an east-west trend in this area to maintain approximate parallelism with the McCallum Granite contact. The garnetiferous leucogranite veins are most profuse in the Little Passage Gneiss along its contact with the McCallum Granite. The veins are common to both units and generally mask the granite/country rock contact. However, xenoliths of Little Passage Gneiss do occur within the McCallum Granite. All three rock units, viz. Little Passage Gneiss, McCallum Granite, and leucogranite veins, are overprinted by the regional first foliation (S_1).

Devonian or Earlier

McCallum Granite (Unit 7)

Definition

The McCallum Granite is a new name proposed here for a coarse grained, feldspar porphyritic, biotite, minor muscovite granitoid that is commonly banded, and occurs in the southern part of the map area. It is named after the small community located at the western entrance to Bonne Bay; excellent coastal exposure of all aspects of the granite occur in that vicinity. Initially, the McCallum Granite was included in the Gaultois Granite (Colman-Sadd, 1974), a relatively homogeneous, coarse grained, feldspar megacrystic, biotite granite that underlies the southern part of Long Island. However, the banding in the McCallum Granite, defined by variations in grain size, biotite concentrations and the amount of feldspar phenocrysts, makes it distinct from the Gaultois Granite.

The McCallum Granite forms a linear pluton that outcrops as far east as Blunder Cove on Long Island and extends westward to the edge of the map area. Its widest extent is a 5 km section in the McCallum area; it narrows to approximately 1 km at the western edge of the map area. The granite intrudes the Little Passage Gneiss along its northern boundary. The Dragon Bay Fault separates it from the Gaultois Granite along its southern boundary, west of Facheux Bay. Contact relationships between the two granites on Long Island suggest they may be coeval. Parts of the Burgeo granite, (Williams, 1978; O'Brien and Tomlin, 1985), west of the Facheux Bay map area, consists of banded granitoid (Blackwood, 1984) which may be a correlative of the McCallum Granite.

Description

The McCallum Granite consists predominantly of variably banded granitoid which locally grades into zones of homogeneous porphyritic granite. The banded variety is generally grayish white weathering, medium to coarse grained, variably porphyritic, biotite granite-granodiorite. For the most part, the banding (interpreted as primary) is defined by variations in grain size, the amount of biotite, and the number of feldspar phenocrysts. Bands are 1 cm to 1 m wide and locally persist in three dimensions with straight, approximately parallel, boundaries; contacts are abrupt but not intrusive (Plate 33). Individual bands consists of equigranular, minor biotite granite, biotite-rich granite, coarse grained, feldspar porphyritic granite, fine to medium grained granodiorite and, rarely, dark gray diorite. These variations are well displayed in the area between Back Cove and Facheux Eye, west of McCallum. Some textural and compositional variations are lensoid and pinch out along strike. Locally, elliptical inclusions of granodiorite occur in granite and vice versa. The granodiorite bands and lenses are either equigranular or contain a few scattered feldspar phenocrysts; commonly, the granodiorite is bounded by profusely porphyritic granite containing



Plate 33: *Banding in granite defined by variations in grain size and the amount of biotite, McCallum Granite (Unit 7) at Bonne Bay.*

pink feldspar phenocrysts that are 0.5 to 4 cm across. Locally, feldspar phenocrysts straddle the boundary between bands of differing composition or texture. Some bands of equigranular granite contain regularly oriented, 2 to 5 mm wide, biotite-rich schlieren.

Although the type of banding which predominates in the McCallum Granite consists of regular bands and lenses, tens of centimetres wide, locally a highly contorted, narrow banding occurs, such as that developed between Facheux Eye and Eastern Head at the entrance to Facheux Bay. It consists of 1 to 2 cm wide, dark gray weathering, biotite-rich lenses that are 20 to 30 cm long and occur in a pinkish white weathering granite. The dark lenses are chaotically distributed and folded such that the granite superficially resembles a migmatite. However, there is no metamorphic component and, in detail, textures are completely igneous. Also these areas are quite distinct from migmatite inclusions in the McCallum Granite, such as the large raft on the east side of Facheux Eye. The banded variety of the McCallum Granite locally passes gradationally into zones of relatively homogeneous, coarse grained, feldspar porphyritic granite, e.g., north of Eastern Head. In these areas, pink feldspar phenocrysts greatly exceed white feldspar phenocrysts; locally, the granite contains single 6 cm long feldspar megacrysts.

A moderate to strong penetrative foliation is developed throughout the McCallum Granite and is defined by oriented biotite and quartz. A widely spaced fracture cleavage overprints the earlier fabric. The granite was intruded syn or pretectonically by tourmaline-muscovite leucogranite aplite and pegmatite dikes that are concordant with, or cross-cut, the banding. Porphyritic granodiorite dikes were also intruded pretectonically.

Petrography

Quartz, orthoclase, microcline, plagioclase and biotite occur in varying proportions in the McCallum Granite. The quartz is concentrated in fine grained, intergranular domains between the much larger feldspar phenocrysts. Locally, domains of elongated quartz define a disoriented fabric, controlled by the orientation of adjacent phenocrysts. The quartz exhibits undulose extinction and sub-grain boundary development; grain boundaries are curved, cuspate and sutured. Potassic feldspar consists of untwinned or simple-twinned orthoclase that is commonly perthitic, and microcline. Quartz, biotite, altered plagioclase, and tourmaline locally form inclusions in the microcline. Myrmekite occurs around the rims of some orthoclase crystals. Plagioclase contains inclusions of quartz and biotite and varies from fresh to variably sericitized crystals. Some phenocrysts show oscillatory zoning which locally is accentuated by selective saussuritization. Other crystals contain inclusion-rich, altered cores but have fresh, clear rims. Biotite is weakly to strongly oriented and variably altered to chlorite. Minor muscovite is also oriented and locally overgrows biotite. Accessory minerals include apatite, sphene, zircon, allanite, sericite, muscovite, chlorite, tourmaline, epidote and opaques.

Structure and Metamorphism

The main regional foliation (S_1) is developed throughout the McCallum Granite. It is approximately parallel to the trend of the contact between the granite and the Little Passage Gneiss. The foliation has mostly gentle to moderate northerly dips east of Facheux Bay and steep dips west of the bay. The foliation is generally a penetrative S-fabric defined by oriented biotite and, locally, by flattened quartz; locally, however, weakly oriented biotite in plan is disoriented in cross-section, suggesting an L-S fabric. Where strongly foliated, feldspar phenocrysts form augen in the fabric planes.

The tectonic foliation is generally parallel, in plan, to the primary banding in the McCallum Granite, but locally intersects the banding in cross-section. Rarely, it is axial planar to small scale folds of the banding. Overall, the foliation and banding follow the regional strike and the contact with the Little Passage Gneiss, suggesting that the McCallum Granite was intruded synkinematically; the coeval deformation could have controlled both the development and orientation of the granitoid bands. Also, the leucogranite veins which synkinematically intrude the Little Passage Gneiss similarly intrude the McCallum Granite. The same regional foliation is developed in both veins and host granite, yet a foliated xenolith of McCallum Granite with an internal moderate fabric, disoriented with respect to S_1 in the vein and the main granite body, was observed in a large leucogranite vein on the east side of Bonne Bay. This suggests that the vein intruded during the deformation of the McCallum Granite with the earliest flattening being recorded in the xenolith.

The McCallum Granite is involved in the Dragon Bay Fault zone west of Facheux Bay. The main fabric in the granite merges with the mylonitic foliation within the steeply dipping fault zone. Feldspar and quartz form oval to round porphyroclasts in granite protomylonite and mylonite (Plate 34); other crystals are reduced to pink and

white streaks 1 to 3 mm wide by 2 to 3 cm long. Some zones of ultramylonite, 1 to 4 cm wide, resemble dark grayish-green chert. Garnet and muscovite porphyroblasts, 1 to 4 mm across, are developed locally in mylonite. Chlorite and epidote are both developed in the most cataclastically reduced granite.

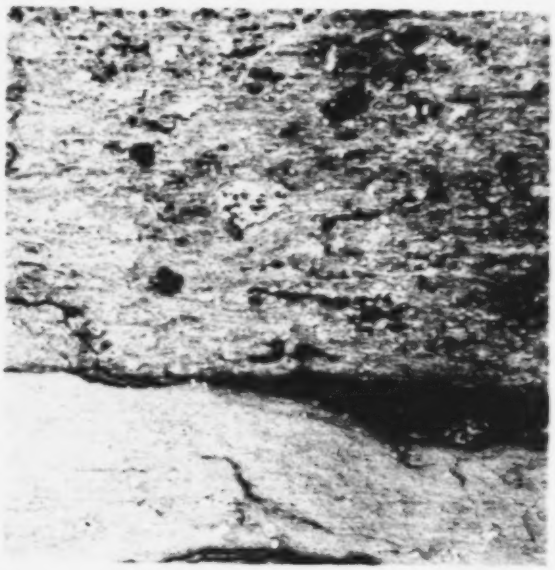


Plate 34: *Feldspar porphyroclasts, feldspar streaks and flattened quartz in protomylonite and mylonite, McCallum Granite (Unit 7) from the Dragon Bay Fault zone at Dragon Bay.*

Deformation lamellae are a common microscopic feature in feldspar porphyroclasts from the Dragon Bay Fault zone. These lamellae are locally superimposed on polysynthetic twinning in plagioclase. The feldspars are generally spindle shaped with tails of finely crushed feldspar tapering off in the fabric planes. Quartz clasts are round or oval, locally with crushed rims. Muscovite porphyroblasts, developed in the finer grained mylonitic rocks, are probably synkinematic since they form spindle shaped augen. Internally kinked cleavage traces occur in some muscovite porphyroblasts and others have recrystallized tails. Some feldspar clasts have microshears which displace twin lamellae. Rarely, granite lithic clasts are preserved. The porphyroclasts of varying size and number occur in a fine grained, quartzofeldspathic matrix with diffuse, slightly elongate, grain boundaries. Sericite, chlorite and fine grained biotite define the foliation and wrap around the porphyroclasts. Fine grained epidote is profusly developed in the matrix; discontinuous streaks of chlorite give the appearance of recrystallized fluxion lines. Chlorite also fills late fractures and locally forms small overgrowing porphyroblasts. Recrystallized stringers of granoblastic to polygonal quartz, and quartz plus plagioclase, occur parallel to the fabric. In one section, a similar quartz-plagioclase segregation outlined an isolated fold hinge. This intrafolial fold may indicate repeated flattening along the mylonite zone. The muscovite and garnet porphyroblasts suggest that mylonitization occurred at greenschist or higher metamorphic grade. Coarsely granoblastic patches in the matrix and chlorite porphyroblasts suggest syn to posttectonic annealing.

A variably developed fracture cleavage overprints the penetrative foliation in the McCallum Granite. It commonly is resolved as a 2 to 4 mm parting with variable dips and a general east-west trend. In the Dragon Bay Fault zone it is manifested as a strain-slip cleavage, axial planar to folds of the mylonitic banding. This fabric is interpreted as the equivalent of S_2 in the Baie d'Espoir Group.

A late fault, marked by a breccia zone several metres wide, is developed in the McCallum Granite on Mosquito Island. Rounded granite clasts with a disoriented internal foliation (S_1) are locally surrounded by fine grained granite breccia of mostly rounded feldspar and quartz (Plate 35). Overall, the granite is orange-pink

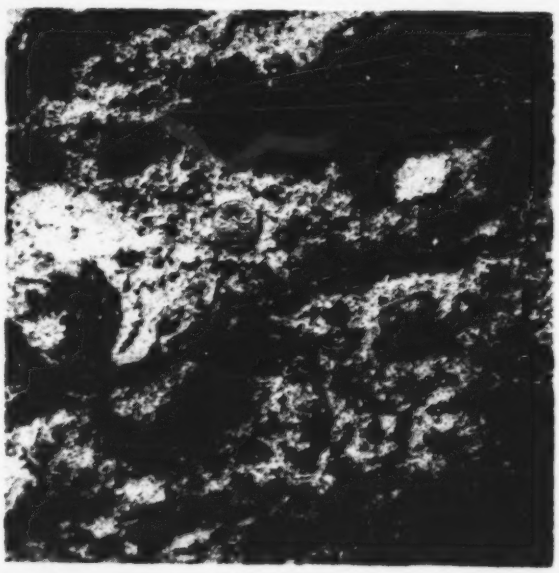


Plate 35: *Granite breccia with rotated clasts containing an internal, disorienated foliation, late fault zone in the McCallum Granite (Unit 7) on Mosquito Island.*

weathering where affected by late faults, and biotite is commonly altered to chlorite. Fine muscovite is locally profuse on shear surfaces in the granite at Blunder Cove on Long Island.

Contact Relationships

The McCallum Granite intrudes the Little Passage Gneiss along its northern contact. Leucogranite veining increases in the granite toward this contact, as it does in the country rocks. Thus the contact is the locus for, and is generally camouflaged by, the synkinematic veins. The McCallum Granite has intruded to different structural levels in the Baie d'Espoir Group. The Little Passage Gneiss is nearly cut out entirely between Facheux Bay and Bay d'Espoir; in that area the boundary related leucogranite veins have pervaded the Stanley Cove Member on the overturned limb of the Manuel Arm Anticline. However, the Little Passage Gneiss has its widest extent on Long Island such that the leucogranite veins peter out entirely between the McCallum Granite and the Stanley Cove Member. Thus, proximity to the McCallum Granite controls the amount of granite veining in the country rocks and, possibly, the local metamorphic grade, since the highest grade rocks in the map area are adjacent to the McCallum Granite, in the leucogranite-intruded zone.

The Dragon Bay Fault forms the southern boundary of the McCallum Granite west of Facheux Bay. Both the McCallum Granite to the north and the Gaultois Granite to the south grade from protomylonite to mylonite within the fault zone. The contact between the two granites on Long Island is not clear cut: veins that may have originated in the McCallum Granite intrude the Gaultois: the coarsely feldspar porphyritic, biotite granite layers in the McCallum are quite similar to the Gaultois. Thus, the two granites may be genetically related or possibly represent different textural varieties of the same pluton.

Gaultois Granite (Unit 8)

Definition

The Gaultois Granite is an informal name proposed by Colman-Sadd (1974) for a coarse grained, feldspar megacrystic, biotite granite that intrudes the Little Passage Gneiss on Long Island. It took its name from the community of Gaultois, located at the southwest corner of the island in the Gaultois (1M/12) map area. Similar granite to the east and west of Long Island was included in the Gaultois Granite. Part of the western portion of the original Gaultois Granite has been redefined here as the McCallum Granite. However, in this report, the name Gaultois is still retained and formally proposed for the coarse grained, biotite rich, megacrystic granite in the eastern part of the Facheux Bay (11P/9) map area that is continuous with the original pluton on Long Island. It contrasts with the relatively inhomogeneous McCallum Granite by having little or no granitoid banding, rare muscovite, and consistently larger feldspar phenocrysts.

The Gaultois Granite intrudes the Little Passage Gneiss east of Blunder Cove on Long Island. Its greatest extent in the map area is west of Facheux Bay where it underlies all the area south of the Dragon Bay Fault.

Description

The Gaultois Granite is a well foliated, coarse grained, feldspar megacrystic, biotite granite that is pink to grayish white weathering. Pink feldspar megacrysts range from 1 to 6 cm long: most are between 3 and 4 cm. White weathering plagioclase crystals are 4 to 10 mm across and occur throughout the granite. Biotite is well developed everywhere and the granite appears to become even richer in biotite towards the contact with the Little Passage Gneiss on Long Island. Locally, biotite is variably altered to chlorite, particularly near fault or shear zones. A biotite poor, sparsely porphyritic, granite phase forms a 7 m wide band in the Gaultois Granite at Muddy Hole: this is the only noted occurrence of banding similar to that in the McCallum Granite.

A variety of foliated granitoids intrude the Gaultois Granite. The most widespread is fine to medium grained, equigranular, biotite granite that predominates in zones up to 0.5 km wide in the area west of Facheux Bay. Feldspar porphyritic, biotite granite and equigranular, biotite-muscovite granite with biotite predominating commonly form dikes in the Gaultois Granite on Long Island. Pink, coarse grained granite dikes and white, locally garnetiferous, two-mica leucogranite dikes also occur. It was noted in a few localities that feldspar megacrysts straddle the contacts between megacrystic granite and granite dikes: this suggests either a metasomatic component to the megacrysts or, that the large feldspars formed projections, around which the intruding material flowed.

Petrography

Microcline and perthitic orthoclase megacrysts dominate in the Gaultois Granite. They contain inclusions of plagioclase, biotite, sphene and quartz. Plagioclase phenocrysts commonly contain biotite inclusions. Myrmekitic lobes occur around

some of the potassic feldspar crystals. Quartz forms polycrystalline domains with straight to curved internal grain boundaries. Locally, elongate domains containing sutured quartz define the penetrative foliation. Brown and green biotite is also concentrated in oriented zones, within which individual crystals are oriented to disoriented. Green hornblende is associated with, and replaced by biotite in some parts of the Gaultois Granite west of Facheux Bay. The penetrative foliation has a cataclastic component in the same area, as demonstrated by bent and displaced twin lamellae in plagioclase crystals. Coarse grained, euhedral sphene, up to 2.5 mm across, and euhedral apatite overgrow biotite locally. Other accessory minerals include zircon and epidote.

Structure and Metamorphism

A pronounced penetrative foliation, correlated with S_1 of the Baie d'Espoir Group, is developed throughout the Gaultois Granite. It is flat to gently north dipping on Long Island; gentle to steep northerly dips occur west of Facheux Bay, becoming steeply dipping with proximity to the Dragon Bay Fault. Generally the foliation is a well developed S-fabric, defined by strongly oriented biotite and flattened quartz (Plate 36). Rarely, such as at the eastern entrance to Sam Hitches Harbour on Long Island, it is an L-S fabric. Except for the Dragon Bay Fault zone itself, the foliation is most intense along the coast west of Facheux Bay, where it merges locally into narrow mylonite zones. Within Dragon Bay, the Gaultois Granite is not as markedly mylonitized as the McCallum Granite. However, protomylonite to ultramylonite zones containing pink feldspar augen and streaks, and ribbon quartz do occur. Muscovite porphyroblasts and minor 3 to 5 mm patches of magnetite were also noted. Locally, the regional mylonitic fabric is cross-cut by 20 to 60 cm wide shear zones containing a margin-parallel mylonitic foliation. A widely spaced fracture cleavage with a 0.5 to 2 cm wide parting is also developed locally.

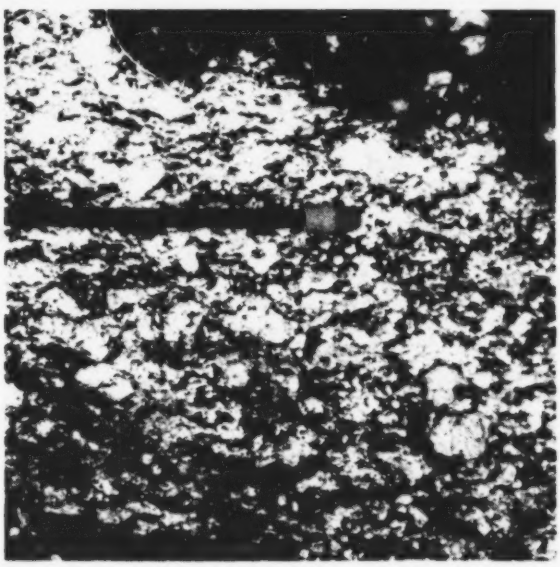


Plate 36: *Intense foliation with flattened quartz and feldspar augen in coarse grained granite, Gaultois Granite (Unit 8) south of the Dragon Bay Fault zone.*

Broken and displaced microcline and orthoclase crystals are characteristic of the Gaultois Granite in the Dragon Bay Fault zone; recrystallized quartz fills some of the cracks in the feldspar. The quartz is intensely strained and elongate. Locally, however, incipient annealing is manifested by very fine grained, diffuse, equant grains of quartz, localized along subgrain boundaries in strained quartz domains. Epidote is common and accessory magnetite occurs in the mylonitized granite, perhaps because of the breakdown of biotite: in one section it was noted that exsolution of magnetite had occurred along rents in a strongly deformed biotite crystal.

The gently northward dipping fault in the Gaultois Granite just east of Blunder Cove is a 6 to 8 m wide breccia zone. It postdates an intense cataclastic fabric in the granite and may mark the site of an earlier mylonite zone. Feldspar porphyritic, biotite-muscovite granite with conspicuous, possibly secondary, muscovite occurs in the hanging wall; typical Gaultois Granite, composed of feldspar megacrystic, biotite granite, occurs in the footwall. Angular, disoriented fragments, 0.5 to 15 mm across, of foliated granite are surrounded by a greenish gray, calcite-rich matrix of crushed granite in the breccia zone. A 40 cm wide, layered zone of calcite (Plate 37) occurs in the center of the fault zone and was probably precipitated in voids along the fault plane. Other lenses and pockets of calcite show a convolute banding that probably mimics the original shape of cavities. Renewed movement has brecciated and displaced the calcite band locally. Pyrite is common in the breccia matrix.

Contact Relationships

The Gaultois Granite intrudes the Little Passage Gneiss along its northern boundary on Long Island. Coarsely recrystallized, pelitic to semipelitic xenoliths are common in the granite at the bottom of Sam Hitches Harbour. The long



Plate 37: *Brecciated, banded calcite layer in granite breccia zone, late fault zone in the Gaultois Granite (Unit 8) east of Blunder Cove on Long Island.*

axes of these inclusions are generally oriented parallel to the tectonic fabric in the granite. Locally, selective feldspar porphyroblast growth produces concordant granitoid-like bands in some xenoliths; this is interpreted as an autometasomatic effect of the Gaultois Granite. Two-mica, garnetiferous leucogranite veins are profuse along the contact, in similar fashion to the northern contact of the McCallum Granite. Stringers and lenses of foliated Gaultois Granite occur as oriented inclusions in the larger leucogranite veins at the bottom of Sam Hitches Harbour. Some inclusions are partially assimilated with mostly biotite trains remaining. Since all elements are parallel to, and contain the main regional foliation (S_1), it is concluded that the leucogranite veins intruded the Gaultois Granite synkinematically.

The contact between the Gaultois and McCallum granites occurs just east of Blunder Cove on Long Island. Equigranular granite included in the McCallum Granite along the east shore of Blunder Cove is quite similar to veins which intrude the Gaultois Granite in the same area. However, similar granitoid veins also intrude banded McCallum Granite elsewhere. Also, coarse grained, homogeneous zones in the McCallum Granite and some of the coarse grained bands could pass for Gaultois type granite. Therefore, the two granites may be intimately related with both intruded by the same types of granite veins. The Gaultois Granite is intruded by the Piccaire granite south of Little Bay on Long Island. It is limited northward by the Dragon Bay Fault west of Facheux Bay; protomylonite grades into ultramylonite, making distinction between the McCallum and Gaultois Granites visually impossible in the central part of the fault zone.

Piccaire Granite (Unit 9)

Definition

The Piccaire granite is an informal name proposed by Colman-Sadd (1974) for a largely equigranular, biotite granite that intrudes the Gaultois Granite on Long Island. It outcrops in a narrow coastal strip around, and west of, the resettled community of Piccaire on the southeastern shore of Long Island, in the Gaultois (1M/12) map area. It continues into the Facheux Bay (11P/9) map area around the Little Bay area of southern Long Island, where it forms a small linear pluton with Gaultois Granite locally occurring on both sides of it. It is not formally named in this report because of its small area of outcrop in the Facheux Bay map area.

Description

The Piccaire granite consists of pinkish white to grayish white weathering granite and granodiorite. It is mostly medium to coarse grained and equigranular, but locally it is sparsely porphyritic with scattered 0.5 to 2 cm long feldspar phenocrysts. Weakly oriented biotite, variably altered to chlorite, is the predominant mica; minor muscovite occurs in some areas. Variations in the amount of biotite define a 0.5 to 8 cm wide banding over a 2 m wide zone in the Piccaire granite west of Wild Cove; it is the only noted occurrence of banding. Muscovite bearing, pink weathering, granite pegmatite and aplite intrude the Piccaire granite.

Petrography

Plagioclase is locally myrmekitic and exceeds microcline and orthoclase. Plagioclase and biotite inclusions occur in the potassic feldspar. Quartz exhibits undulose extinction and incipient subgrain boundary development. Biotite is crudely oriented except in biotite rich zones where it defines a pronounced foliation. Accessory minerals include epidote, carbonate, muscovite, sericite and zircon.

Structure and Metamorphism

A generally weak biotite alignment in the Piccaire granite is regionally concordant with the foliation in the Gaultois

Granite. Locally, however, the fabric is quite intense, e.g., Grassy Island, with flattened quartz also defining the foliation. It was noted in thin section that biotite is strongly oriented in the biotite-rich zones of banded Piccaire granite but weakly oriented to disoriented in biotite-poor granite. It is concluded that the amount of mica (biotite) played an important role in determining how readily the granitoid became foliated.

Contact Relationships

The Piccaire granite intrudes the Gaultois Granite. Large rafts and xenoliths of Gaultois Granite occur in the Piccaire granite around the entrance to Wild Cove. Dikes of the Piccaire granite also intrude the Gaultois Granite and although the fabric is stronger in the latter, it can be seen to continue through the dikes as well. The contrast in the intensity of fabric development between the two granites is probably because of the fact that the Gaultois Granite is relatively richer in biotite. However, the Piccaire granite may have intruded the Gaultois Granite during the late stages of the first deformation.

Leucogranite (Unit 10)

Definition

A sill-like body of leucogranite intrudes the Little Passage Gneiss and is exposed in a narrow linear zone along the north shore of Long Island, between Green Point Cove and Butter Cove. Rich in muscovite and commonly garnetiferous, it is a mappable equivalent, on 1:50,000 scale, of the concordant leucogranite veins that occur throughout most of the Little Passage Gneiss. Its gentle northerly dip and fortuitous occurrence along a rare section of low lying coastline make delineation of the leucogranite possible.

Description

The mostly white weathering leucogranite is fine to medium grained and equigranular to slightly porphyritic. Locally, it contains quartz and feldspar augen up to 1 cm long. Conspicuous muscovite books, 2 to 5 mm across, are profusely developed; most are dimensionally oriented, but disoriented crystals also occur throughout the granite. Small red garnets, generally less than 2 mm across, are common, and minor biotite and tourmaline also occur. The leucogranite locally contains thin, concordant, pegmatite lenses, rich in tourmaline and garnet. These, plus other concordant lenses rich in quartz and muscovite, impart a crude banding to some parts of the leucogranite.

Petrography

Microcline and plagioclase phenocrysts occur in a quartz rich groundmass. Quartz forms separate, elongate grains that are oriented in the fabric planes; smaller equidimensional grains occur with feldspar between the coarser grained elongate quartz. Fine grained, oriented muscovite and even finer biotite, variably altered to chlorite, define the foliation. Large, elongate to stubby muscovite crystals contain quartz inclusions. The granite also contains minor euhedral to subhedral garnet and accessory apatite.

Structure and Metamorphism

S_1 is penetratively developed throughout the leucogranite and has a consistent east-west trend with gentle northerly dips. Locally, the intense fabric contains quartz and feldspar augen. In some parts of the granite a physical parting occurs parallel to the fabric planes, giving the granite a flaggy appearance. The flaggy granite is gradational with more massive granite in sections perpendicular to the fabric planes; this variation is interpreted to represent deformational inhomogeneity. The foliation is also axial planar to isoclinal folds of muscovite rich lenses and bands in the granite at Lee Cove. Although some of the large muscovite books have recrystallized margins, they do not appear (in thin section) to be as deformed as the strongly oriented matrix mica and elongate quartz. It is possible that these coarse, tabular, muscovite flakes are porphyroblastic in origin.

Contact Relationships

The leucogranite intrudes the Little Passage Gneiss. The contact is exposed between the granite and semipelitic to psammitic schist at Lobscouse Cove. S_1 is axial planar to small scale F_1 folds of the contact at that locality.

North Bay Granite (Unit 11)

Definition and Division

The North Bay Granite was named by Jewell (1939) for the two-mica granite that intrudes the northern part of the Baie d'Espoir Group and is well exposed along both sides of North Bay, the entrance to which is at the bottom of Northern Arm in the Facheux Bay (11P/9) map area. Only the southern edge of the vast granitoid terrane included in the North Bay Granite occurs in the map area; most of the granite outcrops to the north in the D'Espoir Brook (11P/16) (Dickson and Tomlin, 1983) and Dolland Brook (11P/15) (Dickson and Delaney, 1984) map areas.

The North Bay Granite forms the northern boundary of the Baie d'Espoir Group in the Facheux Bay map area. For the most part, it is in intrusive contact with the Riches Island Formation, but the granite also intrudes the Little Passage Gneiss west of Facheux Bay, and a small part of the Isle Galet Formation around Northern Arm. An intrusion breccia zone, designated subunit 11a, occurs along the southern margin of the North Bay Granite; the zone varies from approximately 4.5 km wide in the east to 1 km wide in the west. Various rock types of the Baie d'Espoir Group form large concordant rafts which in some areas exceed granite in volume within the breccia zone.

Description

The North Bay Granite (Unit 11) is a fine to coarse grained, generally white weathering, two-mica granite. A medium grained, equigranular variety with scattered 1 to 3 cm long feldspar phenocrysts predominates (Plate 38). However, large areas of feldspar porphyritic granite do occur, particularly west of, and along the west shore of Facheux Bay; the feldspar phenocrysts are mostly pink weathering and 0.5 to 4 cm long. Small, circular to elliptical pods of translucent quartz, 0.5 to 3.0 cm in diameter, occur along the east shore of Facheux Bay, just south of Shoal Cove. Disoriented biotite and muscovite are ubiquitous with biotite predominanting. Small, 3 to 5 cm long, recrystallized pelite/semipelite xenoliths with recognizable primary laminae and/or foliation occur locally. Even smaller biotite-rich clots, 1 cm across, are interpreted to have originated as pelitic inclusions.

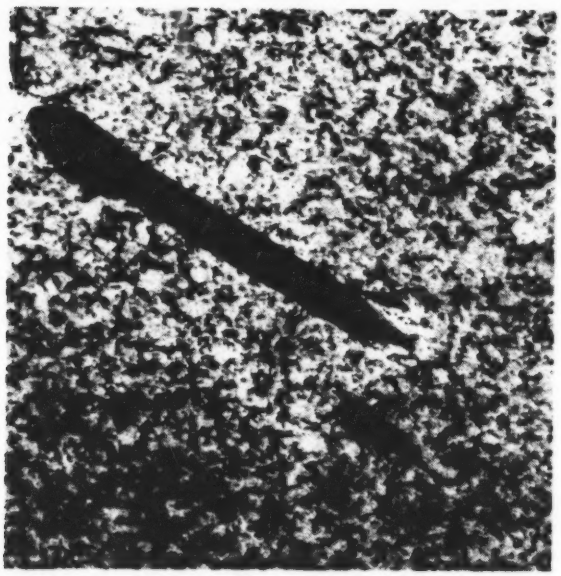


Plate 38: *Equigranular two-mica granite, North Bay Granite (Unit 11) at Facheux Bay.*



Plate 39: *Xenoliths of Riches Island Formation (Unit 5) in the intrusion breccia zone (subunit 11a) of the North Bay Granite at Facheux Bay.*

The intrusion breccia zone (subunit 11a) consists of large concordant rafts of metasedimentary rocks that are oriented parallel to the regional strike, and intervening, similarly oriented, zones of granite. The granite zones commonly contain smaller, disoriented xenoliths and granite veins are profuse in the larger rafts. Some of the rafts appear to be continuous over two kilometres and are hundreds of metres wide; the granite zones are of a similar scale. Raymond Island, the peninsula between Little and Great Cuiller Bays, and North Bay Head, for example, are all underlain by granite. One metasedimentary raft has been delineated on the map north of Brent Cove in Facheux Bay. Some of the smaller, dark gray weathering, xenoliths, tens of metres across, that "float" in white weathering granite are excellently displayed in the steep cliff faces of Facheux Bay (Plate 39). A rough estimate of the relative proportions of granite and country rock within the intrusion breccia zone is 60:40, with the North Bay Granite forming the larger part.

Granite in the intrusion breccia zone is mostly white weathering, medium grained, and equigranular. Locally, however, it con-

tains 2.5 cm long feldspar phenocrysts. Biotite is weakly to moderately oriented and generally exceeds muscovite; both micas are equally developed in some areas, such as at Cul de Sac Point. Rare tourmaline and garnet occur in the main granite phase in the intrusion breccia zone at Facheux Bay. The granite is intruded by a profusion of tourmaline-garnet-muscovite leucogranite aplites and pegmatites. Minor, aquamarine beryl was noted in a pegmatite northeast of Allan's Cove.

The metasedimentary rafts consist mostly of recrystallized psammitic, semipelitic and pelitic schists of the Riches Island Formation, except west of Facheux Bay where migmatite xenoliths occur. A "sugary" recrystallization texture is characteristic of the psammite and minor feldspathic quartzite; porphyroblastic biotite and muscovite are common in the pelitic zones. Primary laminae and bedding are still clearly recognizable in the metasedimentary zones.

Petrography

Microcline and perthitic orthoclase phenocrysts are larger and generally exceed plagioclase in number. Quartz, biotite and altered plagioclase inclusions are common in the orthoclase. Plagioclase phenocrysts are variably sericitized, commonly myrmekitic, and locally show oscillatory zoning. Quartz is highly strained with subgrain boundary development; in the intrusion breccia zone, quartz is locally sutured and elongated in the foliation planes. Biotite is partially altered to chlorite; minor muscovite overgrows biotite. Accessory minerals include apatite, zircon, epidote, and sericite. The biotite-rich clots consist of polygonized quartz and plagioclase, and up to 40 percent mica, dominated by biotite. In one clot, a vague suggestion of a fold defined by fine grained biotite was observed. Quartz is granoblastic to polygonal in the psammitic and semipelitic inclusions. Biotite and muscovite are mimetically recrystallized along S_1 and also accentuate pelitic laminae in semipelite xenoliths; sillimanite (fibrolite) is common in muscovite and also replaces biotite in a metasedimentary raft at Wallace Cove, Facheux Bay.

Structure and Metamorphism

A weakly developed, vertical to moderately south dipping biotite alignment occurs parallel to the regional structural grain in granite within the intrusion breccia zone. However, biotite defines a well developed foliation in some areas, particularly along contacts with metasedimentary rafts, and the contact with the Riches Island Formation at Allan Head, Sugarloaf Point, and Raymond Island.

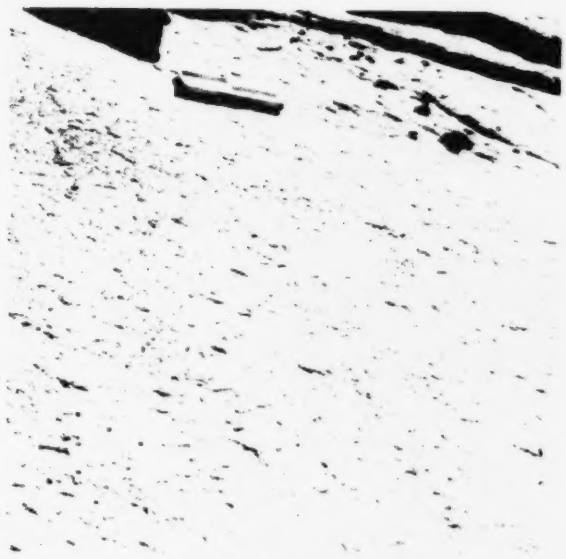


Plate 40: *Well developed fracture cleavage is gently dipping to the south in equigranular granite, North Bay Granite (Unit 11) at Facheux Bay.*

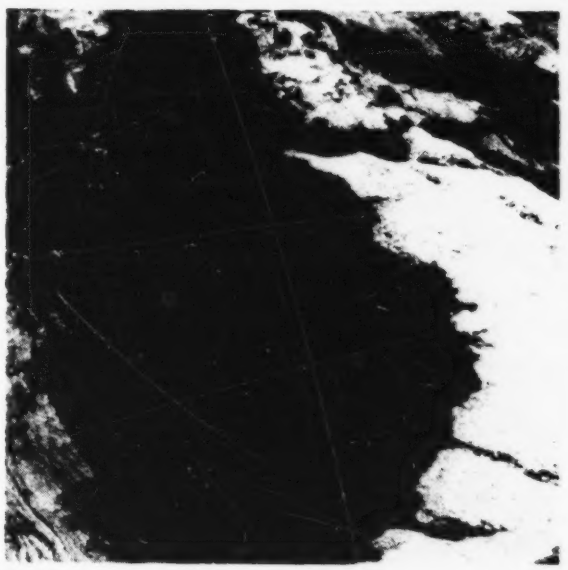


Plate 41: *A vein of North Bay Granite crosscuts bedding and S_1 in a xenolith of the Riches Island Formation; the fracture cleavage in the vein overprints S_1 and is a crenulation cleavage in the metasedimentary xenolith, intrusion breccia zone (subunit 11a) of the North Bay Granite at Facheux Bay.*

Locally, quartz elongation occurs in areas of oriented biotite to produce a penetrative fabric. This fabric, however, is not correlated with the regional deformation of the Baie d'Espoir Group since the North Bay Granite demonstrably postdates S_1 of the country rocks, and the biotite alignment in the granite is only sporadically developed in contact areas. It is not developed at all outside the intrusion breccia zone in the relatively inclusion free part of the North Bay Granite. Therefore it is considered to have formed during the intrusion of the granite, probably induced and controlled by contact related stress.

A weak to well developed fracture cleavage is characteristic of the granite both inside and outside the breccia zone (Plate 40). It is generally east-west trending with gentle southerly dips that truncate the steeper dipping biotite alignment. Weathering accentuates the widely spaced cleavage planes, giving portions of the granite a flaky appearance. This weakly developed fabric in the granite was observed to overprint S_1 in a metasedimentary xenolith at Wallace Cove, Facheux Bay; it is tentatively correlated with S_2 in the Baie d'Espoir Group (Plate 41).

Contact Relationships

The North Bay Granite intrudes the Baie d'Espoir Group resulting in a marginal intrusion breccia zone. The contact between the breccia zone and the main granite is fairly abrupt and is drawn where the granite becomes essentially inclusion free. The North Bay Granite intruded the Baie d'Espoir Group after the development of the first regional foliation, as demonstrated by a variety of porphyroblasts that overgrow S_1 in the granite aureole. The weak to locally strong biotite alignment in the granite is restricted to the contact zone and is parallel to S_1 in the Riches Island Formation. It is interpreted as a contact-related fabric and possibly resulted in some renewed flattening along S_1 in the area adjacent to the North Bay Granite. As previously noted, granite related porphyroblasts in the Isle Galet Formation predate S_2 whereas they are generally syn to post S_2 in the Riches Island Formation. This, coupled with the possibility that the weak flaky cleavage in the granite is correlative with S_2, suggests that the North Bay Granite is a syn D_2 intrusion.

DEPOSITIONAL AND TECTONIC HISTORY

Interpretation of Depositional Environment

The stratigraphic position of rock units within the Isle Galet Formation is known in the Facheux Bay (11P/9) map area. The oldest rocks are laminated pelites and minor, fine grained, felsic tuffs (Unit 1) that occupy the core of the Manuel Arm Anticline. These are gradationally overlain by the Stanley Cove Member (Unit 2), a largely felsic volcanic sequence containing minor sedimentary rocks. The Stanley Cove Member is overlain abruptly, but conformably, by a thin sequence of black graphitic pelite (Unit 3). The pelite is followed by the top unit of the Isle Galet Formation (Unit 4), a thicker sequence of sandstone, amphibolite, intercalated black graphitic pelite, and minor felsic tuff.

The Riches Island Formation was interpreted by Colman-Sadd (1980b) to be the lateral equivalent of the Isle Galet Formation; this appears to be the situation in the Facheux Bay map area. The top of the Isle Galet Formation (Unit 4) occupies the core of the Northern Arm Syncline. It conformably overlies Unit 3 of the Isle Galet Formation on the southern limb of the syncline; on the northern limb, Unit 4 conformably overlies a sequence of psammite, semipelite, and intercalated quartzite (Unit 5) of the Riches Island Formation. Therefore the lower part of the Isle Galet Formation, including the Stanley Cove Member, appears to pass laterally into the Riches Island Formation around the synclinal axis.

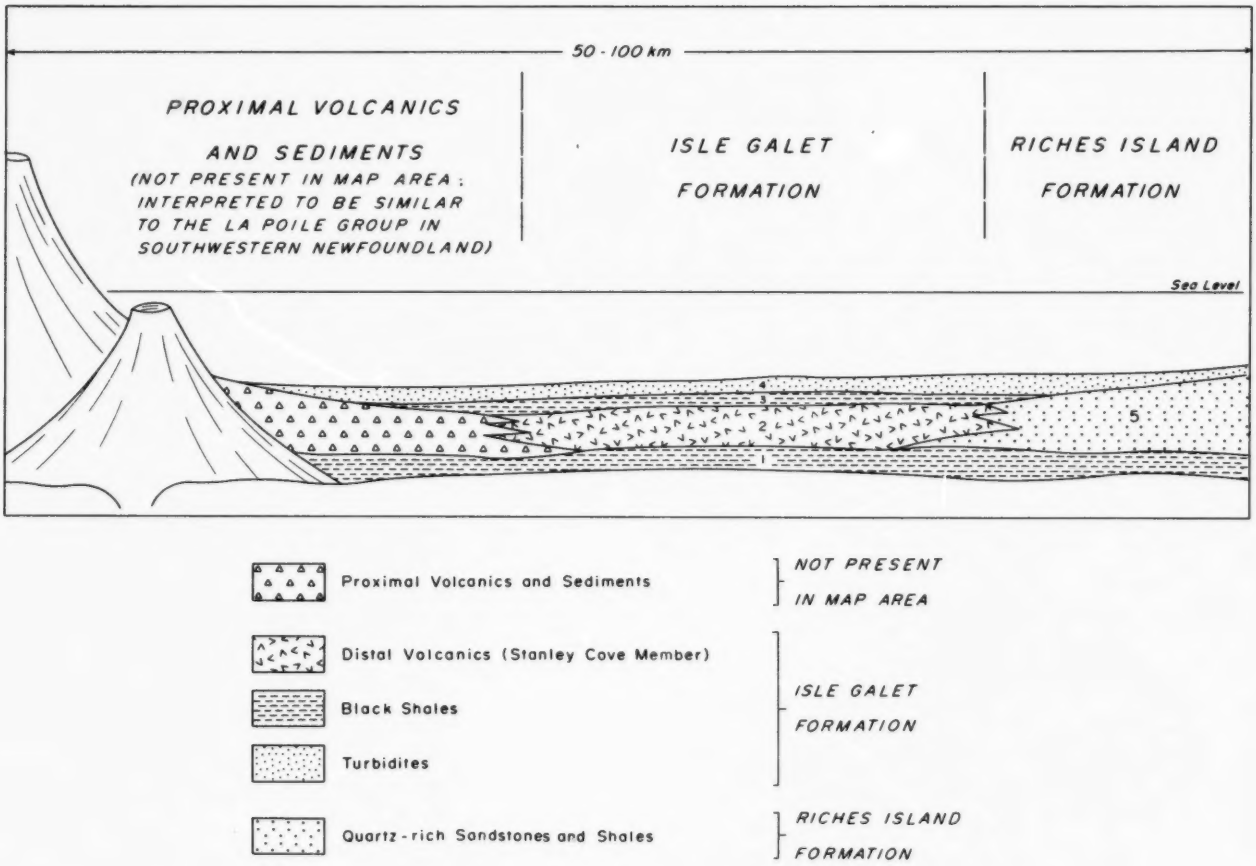
Lapilli tuffs and ash flow tuffs of the Stanley Cove Member were probably deposited in a quiet submarine basin. This is suggested by the thinly laminated, gray to black pelites (Unit 1) that underlie the volcanic rocks (Unit 2). Fine grained, felsic tuff horizons in the underlying pelite probably were harbingers of the relatively thick felsic volcanic sequence to follow. The occurrence of thin, locally graphitic, pelite layers in the volcanic sequence, including those separating individual ash flows, further suggests the quiescent, restricted nature of the submarine basin.

The Stanley Cove Member exhibits lateral facies variations in the extreme eastern and western parts of the member. The more massive ash flow tuffs, including possible rhyolitic flows, volcanic conglomerate, and the coarsest grained lapilli tuffs, which characterize the lower part of the member (2a), all occur between Lampidoes Passage and Facheux Bay. Fine grained, finely laminated tuffs, containing sparse quartz and feldspar crystals, underlie the eastern part of the member on Bois Island. Similarly, in the area west of Facheux Bay, fine grained tuffs dominate. Also, the felsic volcanic rocks on the northern limb of the Manuel Arm Anticline lens out into gray and black pelite west of Facheux Bay. Thus it appears that relatively proximal volcanic rocks in the central part of the Facheux Bay map area pass laterally into a more distal facies to the west and east. Overall, the Stanley Cove Member does not contain rock types indicative of a nearby volcanic centre; Swinden (1982) interpreted the member to have been deposited "in an environment moderately distal to a centre of dominantly rhyolitic volcanism".

The Stanley Cove Member represents two distinct periods of volcanic activity (2a and 2c), separated by the thin clastic unit (2b) that is developed throughout the member. The clastic unit conformably overlies the lower part (2a) of the Stanley Cove Member and represents a return to quiescent conditions since black graphitic pelite is the dominant rock type. The thin marble layer which occurs at the base of the black pelite unit and directly overlies lapilli tuff of subunit 2a may be a recrystallized, arenaceous limestone that developed around topographic highs formed by the initial pulse of volcanism. In this way, it may reflect a similar environment of deposition to Middle Ordovician limestones in central Newfoundland, which are interpreted to have formed around volcanic islands, and are overlain by Caradocian black shale (Dean, 1978). The black pelite zone (2b) also locally contains conglomerate and pebbly siltstone/sandstone lenses that are tentatively interpreted as debris flows. Overall, the limestone(marble)-black pelite association suggests a relatively shallow, restricted marine basin.

A second pulse of volcanism is represented by fine grained felsic tuffs of the upper part (2c) of the Stanley Cove Member. It conformably overlies the clastic unit and appears to be a more distal facies than the earlier, coarse grained, lapilli and ash flow tuffs. This could mean a less forceful eruption from the same volcanic centre or a different, more distant centre. The upper part of the Stanley Cove Member also represents the end of significant volcanic deposition in the Isle Galet Formation, as the volcanic sequence is capped by an even thicker unit of black graphitic pelite (Unit 3). The basin thus reverted back to quiet, restricted, clastic deposition.

The Riches Island Formation (Unit 5) is the lateral equivalent of lower units in the Isle Galet Formation. The proportion of psammite, feldspathic quartzite and quartzite interbedded with laminated semipelite could suggest a shelf facies,



Note: The Little Passage Gneiss (6) is the metamorphic equivalent of parts of the Isle Galet Formation.

Figure 3: *Possible distribution of elements, and relationship to a volcanic centre for rocks of the Baie d'Espoir Group in the Middle Ordovician.*

perhaps marginal to volcanic islands: the relatively high quartz component is interpreted to reflect a felsic volcanic provenance. The shallow marine basin within which the Isle Galet Formation was deposited was probably adjacent to the well-washed, relatively mature, sands of the shelf environment. However, minor black graphitic pelite in the Riches Island Formation indicates areas of quiet, restricted deposition and possible interfingering with the Isle Galet Formation (Fig. 3).

The final phase of sedimentation is represented by the top (Unit 4) of the Isle Galet Formation. Zones of graded sandstone beds are interpreted as turbidites, locally preserving partial Bouma sequences, that were deposited in the marine basin and also overlap possible shelf facies rocks of the Riches Island Formation. The sandstones contain volcanic quartz and lithic clasts indicating erosion of volcanic highs. The persistence of intercalated, black, graphitic pelite suggests turbidite deposition occurred intermittently with quiescent periods of restricted deposition. The thin bands of felsic and mafic tuff that occur throughout Unit 4 attest to sporadic volcanic activity.

Structure

The structure of the Baie d'Espoir Group is dominated by the two regional F_1 folds: the Manuel Arm Anticline in the

south and the Northern Arm Syncline in the north. The anticline is southward facing where overturned to recumbent in the Bonne Bay and east area, becoming just slightly overturned to upward facing in the Facheux Bay area. Thus the gently dipping axial plane at Manuel Arm gradually rotates to a vertical position west of Facheux Bay. Similarly, the northern limb of the syncline is overturned at, and east of, Northern Arm; west of Northern Arm, the fold is upright.

The regional penetrative foliation (S_1) is axial planar to the large-scale folds and its attitude mimics the folds' axial surfaces. S_1 is moderately to steeply north-dipping along the northern part of Northern Arm and has gentle northward dips south of there. The change in dip reflects the progressive overturning from the Northern Arm Syncline in the north to the Manuel Arm Anticline in the south. Moderate to steep dips occur in the Facheux Bay area as the folds change from southward facing, overturned structures in the east to upward facing ones in the west. S_1 is consistently steeper than bedding on the normal or upper limb of the Manuel Arm Anticline and locally graded beds face up on the foliation planes. The vergence of small scale F_1 folds on the upper or northern limb also indicate closure to the south. S_1 is parallel or subparallel to primary layering on the bottom or overturned limb of the anticline. However, along the north shore of Long Island, both bedding-cleavage intersections and vergence of small scale folds indicate that these rocks are on the overturned limb.

S_1 is most strongly developed on the overturned limb of the Manuel Arm Anticline in the Baie d'Espoir Group. Flattening was most intense in this area as demonstrated by the locally pronounced augen structure and flaggy parting in the leucogranite sheets. This resulted in the attenuation of rock units on the overturned limb such that the Stanley Cove Member forms a considerably thinner map unit in that area. Also, it could be expected that the much less competent, graphitic pelite horizon (2b) would be the locus for differential fault movement in this high strain zone. Consequently, it is not surprising to find subunit 2b of the Stanley Cove Member missing from the bottom limb between Manuel Arm and Facheux Bay; an assumed fault marks the boundary between the upper and lower parts (2a and 2c) of the Stanley Cove Member in that region. Similarly, some fault movement may have occurred along a graphitic pelite zone on Long Island, previously interpreted as the Day Cove Thrust.

The structurally lowest rocks of the Baie d'Espoir Group are represented by the Little Passage Gneiss. They occur below the Stanley Cove Member on the overturned limb of the anticline; in the upright part of the fold west of Facheux Bay, the gneisses occur south of the volcanic rocks. An analysis of the fold geometry and stratigraphy described herein suggests that the Little Passage Gneiss is the more metamorphosed equivalent of Units 3 and 4 of the Isle Galet Formation, in the structurally lowest and most deformed part of the Baie d'Espoir Group. Allowing for some differences due to lateral facies variations, the protolith for the Little Passage Gneiss is quite similar to the rocks that stratigraphically overlie the Stanley Cove Member on the upper limb of the Manuel Arm Anticline. Indeed, the occurrence of black graphitic pelite just below the Stanley Cove Member on Long Island may be a vestige of unit 3 since it occupies the correct structural and stratigraphic position on the overturned limb of the anticline.

The Little Passage Gneiss is intruded synkinematically by a southern zone of strongly foliated, biotite granites, e.g., McCallum and Gaultois granites. The penetrative foliation in the granites is equivalent to S_1 in the Baie d'Espoir Group. In the west, this tectonic fabric culminates in a 1 km wide mylonite zone that extends northwestward from Dragon Bay. Mylonites are well exposed along Dragon Bay and hence the mylonite zone is here named the Dragon Bay Fault. The Dragon Bay Fault separates the McCallum and Gaultois granites west of Facheux Bay. Within the 1 km wide mylonite zone, the granite protolith passes gradationally from protomylonite near the margins of the zone to ultramylonite within a narrow 100 to 200 m wide central zone.

The mylonitic foliation is steeply dipping within the Dragon Bay Fault zone, as is S_1 in the McCallum Granite to the north. The fabric is also steep in the Gaultois Granite adjacent to the fault zone but becomes gently northward dipping to the south. Although the strike of the foliation in the Gaultous Granite is generally oblique to the trace of the fault zone, there is no evidence that the mylonitic fabric postdates or overprints a preexisting fabric in the granite. It is the regional foliation which gradually intensifies with proximity to the fault zone, becoming sub-parallel to the trace of the fault near and within the mylonite zone. The regional first foliation gradually changes to a gently, mostly north dipping attitude east of the Dragon Bay Fault; on Long Island even horizontal attitudes occur. This mirrors the change in orientation of the axial surfaces of the two regional folds. Since the development of mylonite along the Dragon Bay Fault and major folding in the Baie d'Espoir Group were concomitant and probably related, the change in attitude from recumbent folds in

the east to upright folds in the west may be a function of a thrust fault evolving into a steeply dipping reverse or even transcurrent fault along strike. Alternatively, the steeply dipping attitude of the S_1 foliations in the west might be related to tight, upright, F_2 refolding, as has occurred outside the Facheux Bay map area, farther west along the Hermitage Flexure (Blackwood, 1984).

D_1 structures are overprinted and refolded by second phase or D_2 structures in the Facheux Bay map area. S_2 is manifested as an east-west trending, variably dipping crenulation or strain-slip cleavage that is superimposed upon S_1, and preferentially developed in pelitic rocks of the Baie d'Espoir Group. It also forms a widely spaced fracture cleavage which overprints the penetrative first fabric in the synkinematic granitoids. S_2 is more penetrative east of Northern Arm than anywhere else in the Facheux Bay map area, forming a composite foliation in the East Bay-Goblin Bay area where it has completely transposed the first fabric. S_2 is axial planar to F_2 folds in the same region; these relatively small folds are downward facing where superimposed upon the overturned limb of the Northern Arm Syncline at Goblin Bay. The most significant aspect of D_2 in the eastern part of the map area is the role it plays in altering the outcrop width of unit 3. The moderately north dipping pelitic unit, which is also relatively narrow west of Northern Arm, becomes openly refolded in the east by F_2 folds, producing the much wider outcrop width in the Goblin Bay-Lampidoes Passage area.

A number of north-south trending vertical faults cut the east-west trending units of the Baie d'Espoir Group. They are most obvious where they cut the Stanley Cove Member and show apparent lateral displacement (mostly dextral) of 50 to 350 m, at Copper Head, Goblin Head, and Bonne Bay area. These faults may be dip-slip rather than strike-slip since the apparent displacement varies along the same fault, being greatest where units have the shallowest dips along the fault, such as the one west of Bonne Bay. The two faults north and west of Bonne Bay appear to be conjugate with the intervening area forming a single fault block.

Metamorphism

The main period of regional metamorphism occurred during the first deformation in the Baie d'Espoir Group. S_1 is defined by sericite and minor biotite, locally containing minor garnet augen, on the upper limb of the Manuel Arm Anticline in the Isle Galet Formation, suggesting it formed under middle to upper greenschist facies conditions. The metamorphic grade increases structurally downward such that the Isle Galet Formation on the bottom limb of the anticline is profusely garnetiferous with coarser grained, prominent biotite defining the main fabric. Quartz and granitoid (quartz and plagioclase) segregations also occur in this area suggesting amphibolite facies metamorphism. The highest grade rocks occur in the Little Passage Gneiss, structurally below the Isle Galet Formation. The amount of quartzofeldspathic recrystallization, *lit-par-lit* granitoid veins, and *in situ* leucosome segregations increase southward in the Little Passage Gneiss, culminating locally in migmatites. The migmatites are spatially related to the synkinematic McCallum Granite suggesting that, locally, ambient metamorphic temperatures were directly increased by the intruding granite. This is supported by the fact that the most highly metamorphosed and veined rocks of the Isle Galet Formation, i.e., Stanley Cove Member on the overturned limb, occur between Manuel Arm and Facheux Bay, where the McCallum Granite has intruded to its highest structural level. On Long Island, where the McCallum and Gaultois granites are spatially farthest removed from the Isle Galet Formation, the Stanley Cove Member is less recrystallized, contains no leucogranite veins and structurally overlies a much less metamorphosed (finer grained schistosity, less porphyroblastic and contains no granitoid segregations), nearly leucogranite-free zone (6a) of the Little Passage Gneiss. Clearly, proximity to the synkinematic granite strongly influences the degree of metamorphism.

The development of leucosome in the semipelitic and psammitic schists to produce migmatite in the Little Passage Gneiss was a syn D_1 event. Most granitoid segregations are concordant with the first fabric or primary layering; folded leucosomes indicate the synkinematic nature of the migmatization. Since the Little Passage Gneiss is mostly a structurally coherent sequence in the central and eastern parts of the map area, it might be argued that some of the migmatites originated by metamorphic segregation (Yardley, 1978) rather than by anatexis. The concordant, *lit-par-lit* nature of granite leucosomes and their mostly quartz-plagioclase compositions would tend to support a metamorphic segregation process which involves diffusion and/or infiltration of minerals (internal metasomatism) from the host rock, and the recrystallization of this material into concordent veins. However potassium feldspar is present in some of the leucosomes and these probably originated by partial melting since potassium feldspar would crystallize from the first formed partial melts (von Platen, 1965) of the pelitic to psammitic protolith. Coalescing of the melt material would cause agmatiza-

tion of the host, resulting in rotated rafts of metasedimentary rocks surrounded by migma: this appears to have occurred in the area west of Facheux Bay. Thus, it is likely that both mechanisms of migmitization, i.e., anatexis and metamorphic segregation, were operative in the Little Passage Gneiss.

The northern part of the Baie d'Espoir Group, particularly the Riches Island Formation, is overprinted by the hornblende hornfels facies within the aureole of the North Bay Granite. Outside the aureole, little or no new mineral growth has occurred along the S_2 crenulation cleavage. Within the aureole, however, S_2 is locally defined by biotite and muscovite, which also wrap around granite-related porphyroblasts, indicating that the North Bay Granite probably intruded during D_2. Recrystallization is also pronounced within the aureole resulting in polygonal textures and mimetically oriented micas.

Tectonic Model

The first period of deformation produced recumbent to locally upright folding in the Facheux Bay map area. A regional penetrative foliation developed axial planar to these folds, locally merging into a narrow mylonite zone. Metamorphic grade increased southward or structurally downward, culminating in a migmatite zone intruded by synkinematic granites. Upright, second deformation folding overprinted the earlier structures and may have developed in response to the intrusion of a post D_1 granite.

A similar style of deformation, metamorphism and granite intrusion affects rocks westward around the Hermitage Flexure. Blackwood (1984) described first phase recumbent folds that were refolded by upright F_2 folds in the Bay du Nord Group. Polarity of the recumbent structures is unknown and the later F_2 folds are more important in controlling the disposition of map units in the Bay du Nord Group than in the Baie d'Espoir Group. However, a regional zone of cataclasis, which also appears to be an extension of the Dragon Bay Fault, is associated with the first deformation of the Bay du Nord Group. Also, the intimate association between synkinematic granites and migmatites persists throughout the Bay du Nord Group (Blackwood, 1984: O'Brien and Tomlin, 1984), generally resulting in a southern zone of high grade metasedimentary rocks and foliated granitoids.

In the northeastern part of the Gander Zone, underlain by the Gander Group and its metamorphic equivalents, the same polarity of deformation and metamorphism exists, i.e., southeastward overturned folds and increasing metamorphism. The eastern belt of migmatites is intruded by strongly foliated, locally cataclastic, megacrystic granites. These migmatites, gneisses and granitoids are limited eastward along the length of the Gander Zone by the Dover-Hermitage Bay Fault (Blackwood and O'Driscoll, 1976: Kennedy et al., 1982), a fundamental mylonite-breccia zone that forms the boundary between the Gander and Avalon zones. There is no Early Paleozoic or older link across this boundary fault. However, the Gander and Avalon zones were juxtaposed by the Late Paleozoic since the Upper Devonian Ackley Granite intrudes both the Gander and Avalon zones, and Devonian conglomerates of the Pools Cove Formation on the Avalon Zone side contain profuse Gander Zone detritus (Williams, 1971b). Metamorphic and plutonic rocks included in the Gander Zone continue around the Hermitage Flexure and are limited westward by the Cape Ray and Long Range Fault systems (Chorlton, 1983). Thus the Hermitage Flexure is bounded in the west and east by major fault systems which also parallel the margins of the Central Mobile Belt (Fig. 4).

The Hermitage Flexure describes a Z-shaped configuration of rock units along the south coast of the island. Williams et al. (1970) first described the flexure and pointed out that similar flexures affect stratigraphic and structural elements throughout the Central Mobile Belt. They interpreted the flexures as late orogenic, open folds about north-trending axes. Brown and Colman-Sadd (1976) interpreted the Hermitage Flexure as an internal feature of the eastern crystalline belt, with the curvature of the flexure being "the result of interference by basement highs and (or) syntectonic granite plutons during recumbent folding". The Hermitage Flexure, and the other flexures in central Newfoundland, is interpreted here as a fundamental feature of the Central Mobile Belt. Therefore any explanation of its origin must include processes that have affected the orogen as a whole. Since the linear, vertical faults which border the Gander Zone and the Central Mobile Belt generally exhibit abrubt changes in lithology, stratigraphy, metamorphic grade and structural style across them, they probably originated as strike-slip faults. It is proposed here that these faults represent major, wrench-fault systems, and as such were responsible for the curvature of rock units around the Hermitage Flexure and the other flexures developed throughout the Dunnage Zone.

The sense of rotation implied by the Hermitage Flexure demands sinistral movement along the boundary faults. Assuming that the Dover-Hermitage Bay Fault is a sinistral wrench fault, then the counter-clockwise, external (or regional) rotation

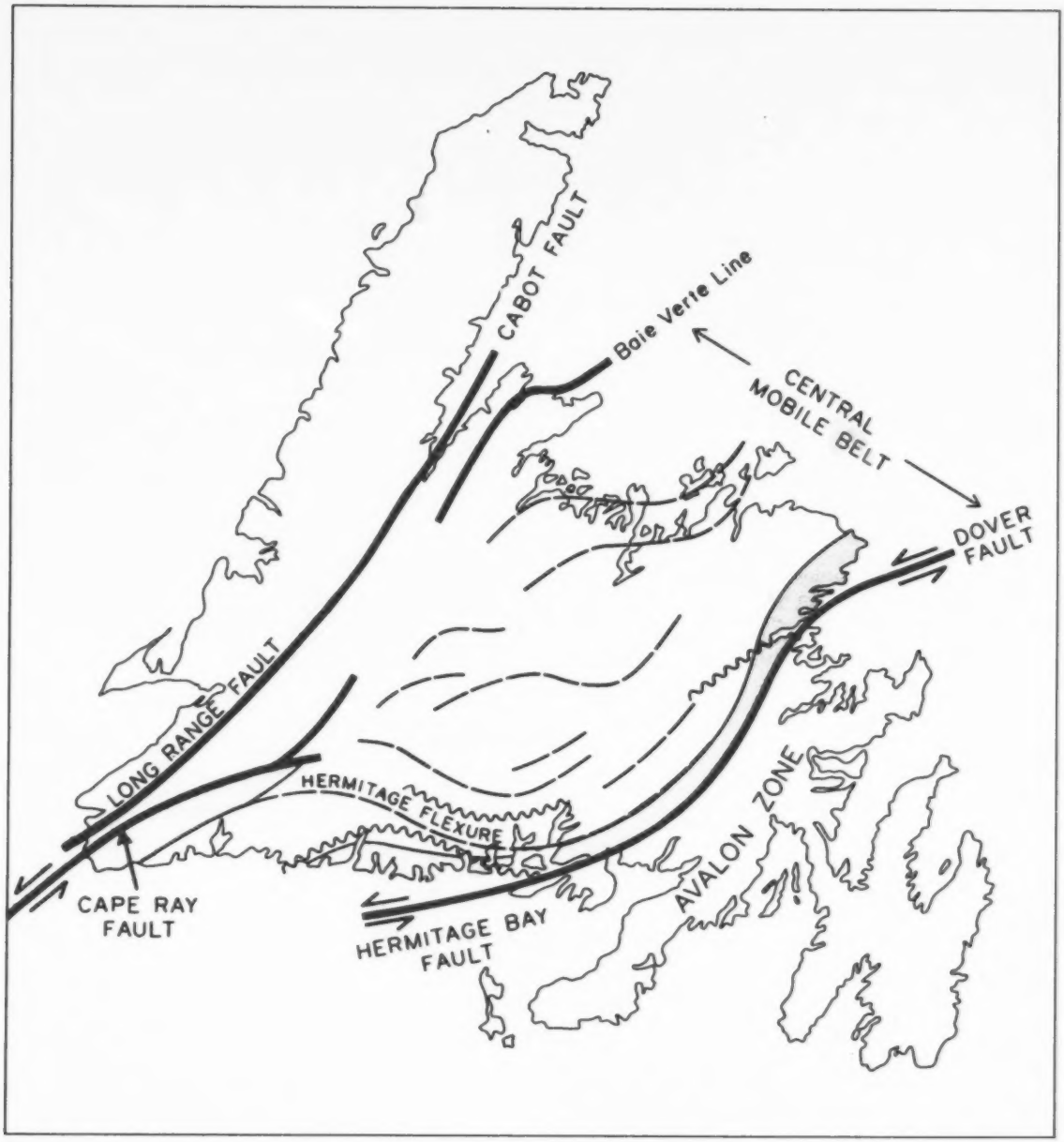


Figure 4: *The Dover-Hermitage Bay Fault and the Cape Ray Fault, interpreted as major, sinistral, wrench-fault systems which resulted in the clockwise rotation of the Central Mobile Belt, producing the Hermitage Flexure and subsidiary flexures in central Newfoundland. The shaded areas represent the general distribution of migmatites in the Gander Zone adjacent to the boundary faults.*

of elements that occur along a sinistral fault (Wilcox et al., 1973), will produce the southward facing *convexity* that defines the eastern part of the Hermitage Flexure on the west side of the Dover-Hermitage Bay Fault. The same sense of movement along the Cape Ray Fault (Chorlton, 1983) and possible early movement on the Long Range-Cabot Fault, will produced the southward facing *concavity* that defines the western part of the Hermitage Flexure, on the east side of the Cape Ray Fault. The overall effect of counterclockwise rotation along both these boundary faults is to produce a general *clockwise* rotation of the area between them, reflected in the sinuous, Z-shaped flexures that are developed throughout the Central Mobile Belt (Fig. 4).

The deformation, metamorphism and granite intrusion that form the common signature of the Gander Zone, from its northeastern portion through to the area around the Hermitage Flexure, are interpreted to be related to the wrench-fault systems described above. The extended, southward traces of the Dover Fault and the Cape Ray Fault suggest that together these faults represent convergent wrench faults. Thus the area between them was a zone of enhanced compressive structures, including conjugate, strike-slip faulting, reverse faulting, thrust faulting and overturned folding. *En échelon* folds commonly show curved axial traces consistent with the direction of offset in wrench systems, like the folds in the Facheux Bay area. Coeval, synthetic, strike-slip faults may locally have a dip-slip or thrust component for which the Dragon Bay Fault is a reasonable analogue. Other strike-parallel mylonite zones in southwestern Newfoundland probably originated as low angle conjugate (synthetic) faults to the main wrench faults. Vertical faults which truncate the structural trend at high angles along the south coast, and are also possibly mirrored in the north-south trending fiords, are interpreted as antithetic faults. The southward or structurally downward increasing metamorphism in the central and eastern part of the Hermitage Flexure may be the result of shear heating that took place along the main, through-going, wrench fault represented by the Dover-Hermitage Bay Fault. This would explain the consistent polarity of increasing metamorphism in the Gander Zone towards the Gander/Avalon zone boundary. Hanmer (1981) first suggested that the metamorphic gradient in the Gander Zone was due to heating associated with an Acadian sinistral shear zone but he considered the Gander Zone itself, rather than the Dover Fault, as the main shear zone. Granite melts may have been produced deep down along the shear zone (Strong, 1980), giving rise to the granitoids characteristics of the Gander Zone. However, increasing ambient temperatures due to tectonic loading (crustal thickening) would achieve the same results, with subsequent uplift of the Gander Zone along the Dover Fault exposing the deeper roots of the orthotectonic belt. In the area of convergence represented by the south coast area of Newfoundland, continued wrenching almost certainly resulted in uplift of the constrained area (see also, Chorlton, 1983). This provided a ready source for the Devonian sediments, locally rich in Gander Zone metamorphic detritus, that were deposited in the relatively low-lying area of the adjacent Avalon Zone in southern Newfoundland.

Sinistral movement on the Cape Ray and Dover faults means that the Avalon Zone moved north relative to the ancient North America craton, slipping along the eastern margin of the Central Mobile Belt (Fig. 5). It may have slightly underthrust the Gander Zone at the same time, as suggested by the polarity of structures in the crystalline belt. Thus some granites in the Gander Zone may compositionally and spatially reflect the degree to which the Avalon Zone extends beneath, and interacts with, the Gander Zone at depth. The Ackley Granite, for example, intrudes both the Gander and Avalon Zones and is interpreted by Tuach et al. (in press) to have an Avalonian geochemical signature west of the Dover Fault. The age of synkinematic granites and related metamorphism in the Gander Zone suggests that tectonism along the southeastern margin of the Central Mobile Belt was initiated at least by the Early Silurian. The posttectonic Ackley Granite indicates that displacement of the Avalon Zone relative to the Central Mobile Belt had ended by the Late Devonian.

MINERALIZATION

Most of the mineral showings in the Facheux Bay area occur in the fine grained, sericite phyllite band (1a) west of Facheux Bay. Interpreted as fine grained felsic tuff, it forms part of the pelite sequence at the base of the Isle Galet Formation. NALCO discovered the first mineralization (a galena prospect) in the tuff band during a major mapping program of their concession area in 1954 (Dunlop, 1954). Follow-up work the following year (Berrange, 1955), including installation of a picket-line grid, mapping and prospecting, led to the discovery of several new base metal occurrences along the felsic tuff band. These occurrences consist of vein and massive sulfides including galena, sphalerite, pyrrhotite, chalcopyrite, arsenopyrite and pyrite. Several of these occurrences were trenched (Stewart, 1955) and a vertical loop EM was carried out over the grid (McPhar Geophysics, 1955). Recommendations to test the resulting conductors were not

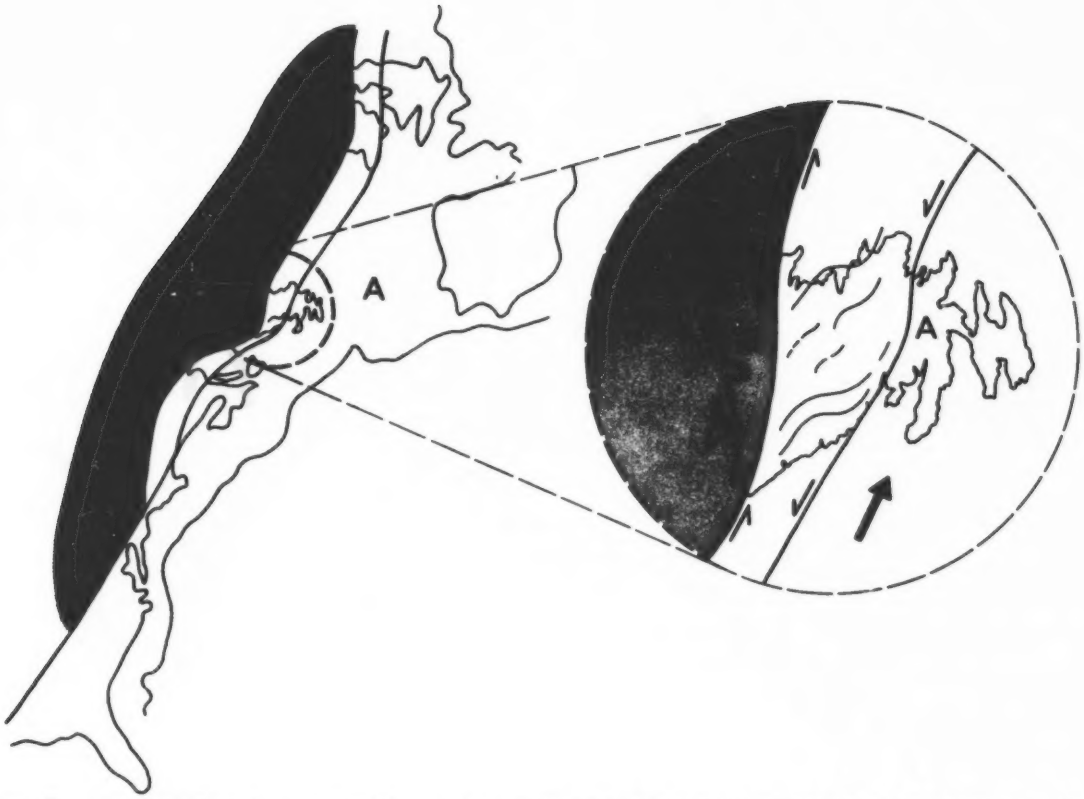


Figure 5: *Newfoundland Appalachians in restored Appalachian-Caledonian Orogen, showing general distribution of Avalonian (A) and Grenvillian (G) rocks (after Williams, 1984). Enlarged area shows the movement direction of the Avalon Zone relative to North America and the sense of displacement along faults bordering the Central Mobile Belt.*

followed up. All of Nalco's concession work was later summarized by Stewart (1958).

Falconbridge Nickel Mines Limited included the Facheux Bay area in a larger mapping project of an area optioned from NALCO. Work was concentrated on the Isle Galet Formation and included 1:12,500 scale mapping and airborne EM (Hinchey, 1978). In 1979, Falconbridge relinquished this ground.

A thorough investigation of the old NALCO showings west of Facheux Bay was made by Swinden (1980). All the details of the previous work as well as Swinden's own observations and conclusions are presented in a comprehensive report on the geology and mineral potential of south-central Newfoundland (Colman-Sadd and Swinden, 1982). They consider the mineral occurrences to be of a relatively minor nature, apparently stratiform, and probably volcanogenic. This interpretation is supported by the consistent occurrence of these showings in the same tuffaceous band or lense in the lowest unit of the Isle Galet Formation. It was also noted that some of the 10 to 45 cm wide mineralized zones were folded by small scale folds (Swinden, 1980); the sulfides appear to be remobilized locally and concentrated in the fold hinges.

Disseminated pyrite is ubiquitous in the graphitic pelites throughout the map area. Pyrite also occurs in the thin limestone (marble) horizon at the base of subunit 2b of the Stanley Cove Member at Goblin Head: it is concentrated in concordant lenses, 1 to 4 mm wide, that are parallel to laminae in the carbonate. Disseminated pyrite also occurs throughout the carbonate and in the underlying, white weathering, massive siliceous rock interpreted as a chert horizon. Disseminated pyrite in the white cherty horizon and overlying carbonate produces a pronounced rusty zone at the Copper Head showing, where subunit 2b is displaced along a north-south fault at the eastern entrance

to Lampidoes Passage. Swinden (1980) interpreted the massive, siliceous, host rock as strongly silicified, felsic tuff. A pyrite showing was also found in the upper part of the Stanley Cove Member (subunit 2c) west of Facheux Bay where massive, fine grained, white to dark gray weathering, rhyolite or chert contains a 25 to 30 cm wide zone rich in pyrite. The felsic host rock is fragmental in the mineralized zone with pyrite forming anastomosing stringers around relatively pyrite free fragments of felsic material. Poor exposure in this locality prevented the determination of strike continuity of either the host rock or the pyrite-rich zone.

A previously unreported pyrite-pyrrhotite-chalcopyrite showing occurs in the top part of the Isle Galet Formation (unit 4) between Little Goblin and Middle Goblin bays. It was discovered by Mr. Frank Benoit of Bay Nord (North Bay) sometime before the First World War (Larry Benoit, personal communication, 1985). Frank Benoit's son, Larry Benoit of Bay d'Espoir, took Newfoundland government geologists S.P. Colman-Sadd and H.S. Swinden to the locality in 1983. The showing occurs in a felsic tuff band similar to others within Unit 4. H.S. Swinden (personal communication, 1985) describes the mineralization as pods and lenses of massive pyrrhotite that are 12 to 15 cm long by 2 to 4 cm wide; these may represent a boudinaged, mineralized bed. Pyrite occurs in pods and is also disseminated in profuse quartz veins that locally represent up to 40 percent of the outcrop. Minor chalcopyrite was noted as well.

Mineral occurrences in the Facheux Bay area were discussed in the context of volcanogenic models by Colman-Sadd and Swinden (1982). It was proposed that the occurrences represent distal deposits related to a distant, exhalative, volcanic source (Colley, 1976). Colley's model involves the transportation of mineral precipitates away from a vent and the subsequent deposition of ores in a marine basin of dominantly sedimentary rocks interbedded with lesser pyroclastic rocks. The Isle Galet and Riches Island Formations probably were deposited in that type of environment. Thus sedimentary rocks both below and above the Stanley Cove Member are good targets for mineralization and attention should not be focused exclusively on the volcanic rocks.

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REFERENCES

Note: *Mineral Development Division file numbers are included in square brackets at end of each unpublished report.*

Anderson, F.D.
1965: Belleoram, Newfoundland. Geological Survey of Canada, Map 8-1965 (geological map and descriptive notes).

1967: Structural studies in the Baie d'Espoir Group, Newfoundland. *In* Collected papers on geology of the Atlantic region - Hugh Lilly Memorial Volume. *Edited by* E.R.W. Neale and H. Williams. Geological Association of Canada, Special Paper 4, pages 193-200.

Berrange, J.P.
1955: Field report on Dennis Arm area. NALCO unpublished report, 15 pages. [11P/9 (4)]

Blackwood, R.F.
1977: Geology of the east half of the Gambo (2D/16) map area and the northwest portion of the St. Brendan's (2C/13) map area, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 77-5, 20 pages.

1978: Northeastern Gander Zone, Newfoundland. *In* Report of Activities for 1977. *Edited by* R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-1, pages 72-79.

1982: Geology of the Gander Lake (2D/15) and Gander River (2E/2) area. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-4, 56 pages.

1983: Geology of the Facheux Bay map area (11P/9), Newfoundland. *In* Current Research. *Edited by* M.J. Murray, P.D. Saunders, W.D. Boyce and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 26-40.

1984: Geology of the west half of the Dolland Brook map area (11P/15), southern Newfoundland. *In* Current Research. *Edited by* M.J. Murray, J.G. Whelan and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 198-209.

Blackwood, R.F. and Kennedy, M.J.
1975: The Dover Fault: western boundary of the Avalon Zone in northeastern Newfoundland. Canadian Journal of Earth Sciences, Volume 12, pages 320-325.

Blackwood, R.F. and O'Driscoll, C.F.
1976: The Gander-Avalon Zone boundary in southeastern Newfoundland. Canadian Journal of Earth Sciences, Volume 13, pages 1155-1159.

Brown, P.A. and Colman-Sadd, S.P.
1976: Hermitage Flexure: figment or fact? Geology, Volume 4, pages 561-564.

Chorlton, L.B.
1978: Geology of the La Poile area (11O/9), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-5, 14 pages.

1980: Geology of the La Poile River map area (11O/16), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-3, 85 pages.

1983: Geology of the Grandys Lake area (11O/15), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-7 (Part I), 116 pages.

Colley, H.
1976: Classification and exploration guide for Kuroko-type deposits based on occurrences in Fiji. Transactions of the Institute of Mining and Metallurgy, Volume 85, pages B190-B199.

Colman-Sadd, S.P.
1974: The geological development of the Bay d'Espoir area, southeastern Newfoundland. Unpublished Ph.D. thesis, Memorial University of Newfoundland, St. John's, 271 pages.

1976: Geology of the St. Alban's Map-Area, Newfoundland (1M/13). Newfoundland Department of Mines and Energy, Mineral Development Division, Report 76-4, 19 pages.

1980a: Geology of the Twillick Brook map area (2D/4), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 79-2, 23 pages.

1980b: Geology of south-central Newfoundland and evolution of the eastern margin of Iapetus. American Journal of Science, Volume 280, pages 991-1017.

Colman-Sadd, S.P., Greene, B.A. and O'Driscoll, C.F.
1979: Gaultois, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 79-104.

Colman-Sadd, S.P. and Swinden, H.S.
1982: Geology and mineral potential of south-central Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-8, 102 pages.

Cooper, J.R.
1954: The La Poile - Cinq Cerf map area, Newfoundland. Geological Survey of Canada, Memoir 256, 62 pages.

Dean, P.L.
1978: The volcanic stratigraphy and metallogeny of Notre Dame Bay, Newfoundland. Memorial University of Newfoundland, Geology Report 7, 204 pages.

Dickson, W.L. and Tomlin, S.L.
1983: Geology of the D'Espoir Brook map area and part of the Facheux Bay map area, south-central Newfoundland. *In* Current Research. *Edited by* M.J. Murray, P.D. Saunders, W.D. Boyce and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 51-56.

Dickson, W.L. and Delaney, P.W.
1984: Geology of the Wolf Mountain (12A/2E) and Dolland Brook (11P/15E) map areas, south-central Newfoundland. *In* Current Research. *Edited by* M.J. Murray, J.G. Whelan and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 232-241.

Dunlop, W.B.
1954: Exploration in the Bay d'Espoir area. NALCO unpublished report, 13 pages. [1M (41)]

Hanmer, Simon
1981: Tectonic significance of the northeastern Gander Zone, Newfoundland: an Acadian ductile shear zone. Canadian Journal of Earth Sciences, Volume 18, pages 120-135.

Hinchey, J.
1978: Geological investigation, NALCO Lot 2, Bay d'Espoir N.T.S. 1M/13, 11P/9. Falconbridge Nickel Mines Limited, unpublished report, 28 pages.

Jenness, S.E.
1958: Geology of the Gander River Ultrabasic Belt, Newfoundland. Geological Survey of Newfoundland, Report 11, 58 pages.

Jewell, W.B.
1939: Geology and mineral deposits of the Baie d'Espoir area. Geological Survey of Newfoundland, Bulletin 17, 29 pages.

Kennedy, M.J. and McGonigal, M.H.
1972: The Gander Lake and Davidsville Groups of northeastern Newfoundland: new data and geotectonic implications. Canadian Journal of Earth Sciences, Volume 9, pages 452-459.

Kennedy, M.J., Blackwood, R.F., Colman-Sadd, S.P., O'Driscoll, C.F. and Dickson, W.L.
1982: The Dover-Hermitage Bay Fault: boundary between the Gander and Avalon zones, eastern Newfoundland. *In* Major Structural Zones and Faults of the Northern Appalachians. *Edited by* P. St-Julien and J. Béland. Geological Association of Canada, Special Paper 24, pages 231-247.

McPhar Geophysics Limited
1955: Report on the electromagnetic survey in the Facheux Bay area, Newfoundland. For Newfoundland and Labrador Corporation. Unpublished report, 6 pages. [11P/9 (3)]

Murray, A. and Howley, J.P.
1881: Geological Survey of Newfoundland (Reports for 1864 through 1880). Edward Stanford, London, 536 pages.

O'Brien, S.J.
1983: Geology of the eastern half of the Peter Snout map area (11P/13E), Newfoundland. *In* Current Research. *Edited by* M.J. Murray, P.D. Saunders, W.D. Boyce and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 57-67.

O'Brien, S.J. and Tomlin, S.
1984: Geology of the White Bear River map area (11P/14), southern Newfoundland. *In* Current Research. *Edited by* M.J. Murray, J.G. Whelan and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 220-231.

1985: Geology of the Burgeo map area (11P/12), southwestern Newfoundland. *In* Current Research. *Edited by* K. Brewer, D. Walsh and R.V. Gibbons. Newfoundland Department of Mines and Energy, Report 85-1, pages 114-123.

Stewart, K.J.
1955: Detail of trenches and reconnaissance soil test, Dennis Arm. NALCO unpublished report, 15 pages. [11P/9 (4)]

1958: Outline of known mineral occurrences within NALCO concessions. NALCO unpublished report, 149 pages. [Nfld. (111)]

Strong, D.F.
1980: Granitoid rocks and associated mineral deposits of eastern Canada and western Europe. *In* The Continental crust and its mineral deposits. *Edited by* D.W. Strangeway. Geological Association of Canada, Special Paper 20, pages 741-769.

Swinden, H.S.
1980: Economic geology of the eastern Hermitage Flexure. *In* Current Research. *Edited by* C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 100-109.

1982: Metallogenesis in the Bay d'Espoir area, southern Newfoundland: summary and implications for regional metallogeny in the Newfoundland Central Mobile Belt. Canadian Mining and Metallurgical Bulletin, Volume 75, Number 839, pages 172-183.

Tuach, J., Kerrich, R., Strong, D.F. and Willmore, L.M.
1985: Variations in oxygen isotope ratios related to source terranes and to hydrothermal regimes in the Ackley Granite, Newfoundland. *In* Granite-Related Mineral Deposits: extended abstracts of papers presented at the CIM conference on granite-related mineral deposits, September 15-17, 1985, Halifax, Canada. *Edited by* R.P. Taylor and D.F. Strong. CIM Geology Division, pages 285-289.

von Platen, H.
1965: Experimental anatexis and genesis of migmatites. *In* Controls of Metamorphism. *Edited by* W.S. Pitcher and G.W. Flinn. Edinburgh, Oliver and Boyd, pages 203-218.

Wilcox, R.E., Harding, T.P. and Seely, D.R.
1973: Basic wrench tectonics. American Association of Petroleum Geologist Bulletin, Volume 57, pages 74-96.

Williams, H.
1971a: Burgeo (east half), Newfoundland. Geological Survey of Canada Map 1280A.

1971b: Geology of the Belleoram map-area, Newfoundland (1M/11). Geological Survey of Canada, Paper 70-65, 39 pages.

1978: Tectonolithofacies map of the Appalachian Orogen. Memorial University of Newfoundland, Map 1.

1979: Appalachian Orogen in Canada. Canadian Journal of Earth Sciences, Volume 16, pages 792-807.

1984: Miogeosynclines and suspect terranes of the Caledonian-Appalachian Orogen: tectonic patterns in the North Atlantic region. Canadian Journal of Earth Sciences, Volume 21, pages 887-901.

Williams, H., Kennedy, M.J. and Neale, E.R.W.
1970: The Hermitage Flexure, the Cabot Fault, and the disappearance of the Newfoundland Central Mobile Belt. Geological Society of America Bulletin, Volume 81, pages 1563-1568.

1974: The northeastward termination of the Appalachian Orogen. *In* Ocean Basins and Margins, Volume 2. *Edited by* A.E.M. Nairn and F.G. Stehli. Plenum Press, New York, pages 79-123.

Winkler, H.G.F.
1967: Petrogenesis of Metamorphic Rocks. Springer-Verlag New York Inc., 237 pages.

Wit, M.J. de
1976: Metamorphic textures and deformation: a new mechanism for the development of syntectonic porphyroblasts and its implications for interpreting timing relationships in metamorphic rocks. Geological Journal, Volume 11, pages 71-100.

Yardley, Bruce W.D.
1978: Genesis of the Srogit Gneiss migmatites, Washington, and the distinction between possible mechanisms of migmatization. Geological Society of America Bulletin, Volume 89, pages 941-951.

LEGEND

DEVONIAN OR EARLIER

NORTH BAY GRANITE (Unit 11)

11	*Fine to coarse grained, equigranular to porphyritic, two-mica (biotite > muscovite) granite;* **11a,** *intrusion breccia zone between the North Bay Granite and the Baie d'Espoir Group: large rafts of pelitic to psammitic schist and migmatite alternate with zones of granite that contain variably sized metasedimentary xenoliths.*
10	*Fine to medium grained, mostly equigranular, two-mica (muscovite > biotite), garnetiferous leucogranite.*

PICCAIRE GRANITE

9	*Medium to coarse grained, mostly equigranular, biotite granite to granodiorite.*

GAULTOIS GRANITE

8	*Coarse grained, feldspar megacrystic, biotite granite; locally includes zones of fine to medium grained, equigranular, biotite granite.*

McCALLUM GRANITE

7	*Fine to coarse grained, equigranular to feldspar porphyritic, biotite granite to granodiorite that is commonly banded.*

MIDDLE ORDOVICIAN OR EARLIER

BAIE D'ESPOIR GROUP (no stratigraphic order implied)

Little Passage Gneiss

6	*Pelitic, semipelitic and psammitic schist including amphibolite and migmatite; intruded by profuse, concordant, leucogranite veins;* **6a,** *laminated pelite, semipelite, psammite and amphibolite with minor, fine grained, felsic tuff bands.*

Riches Island Formation

5	*Laminated, commonly porphyroblastic, semipelite that locally contains coticule bands, and thin to thick bedded psammite; includes minor quartzite and arkosic arenite.*

Isle Galet Formation (units 1 to 4; stratigraphic order implied)

4	*Graphitic pelite, semipelite, thin to thick bedded arkosic arenite, and banded concordant amphibolite; minor felsic crystal tuff, mafic tuff and psammite;* **4a,** *concordant amphibolite zones with fine grained schistose margins and massive, medium to very coarse grained centres.*
3	*Mostly black graphitic pelite with minor felsic tuff, amphibolite and arenite.*
2	*STANLEY COVE MEMBER: felsic volcanics and minor sedimentary rocks.* **Northern Zone: 2a,** *fine to coarse grained, felsic, lapilli tuff containing variable amounts of quartz and feldspar crystals, massive ash flow tuffs with minor interflow pelite, minor, fine grained, thinly laminated, felsic tuff with scattered quartz crystals, and minor volcanic conglomerate;* **2b,** *black, graphitic pelite with local zones of sandstone, conglomerate and minor marble;* **2c,** *mostly fine grained felsic tuff with few crystal clasts; minor quartz-rich lapilli tuff, mafic tuff, and volcanic conglomerate.* **Southern Zone: $2a_1$,** *fine grained, laminated, felsic, lapilli tuff with scattered quartz and feldspar crystals; locally garnetiferous;* **$2b_1$,** *graphitic pelite, richly garnetiferous;* **$2c_1$,** *recrystallized, locally garnetiferous, felsic tuff; intruded by a profusion of concordant leucogranite veins (50% or more of outcrop area of 2c) in the area west of Manuel*

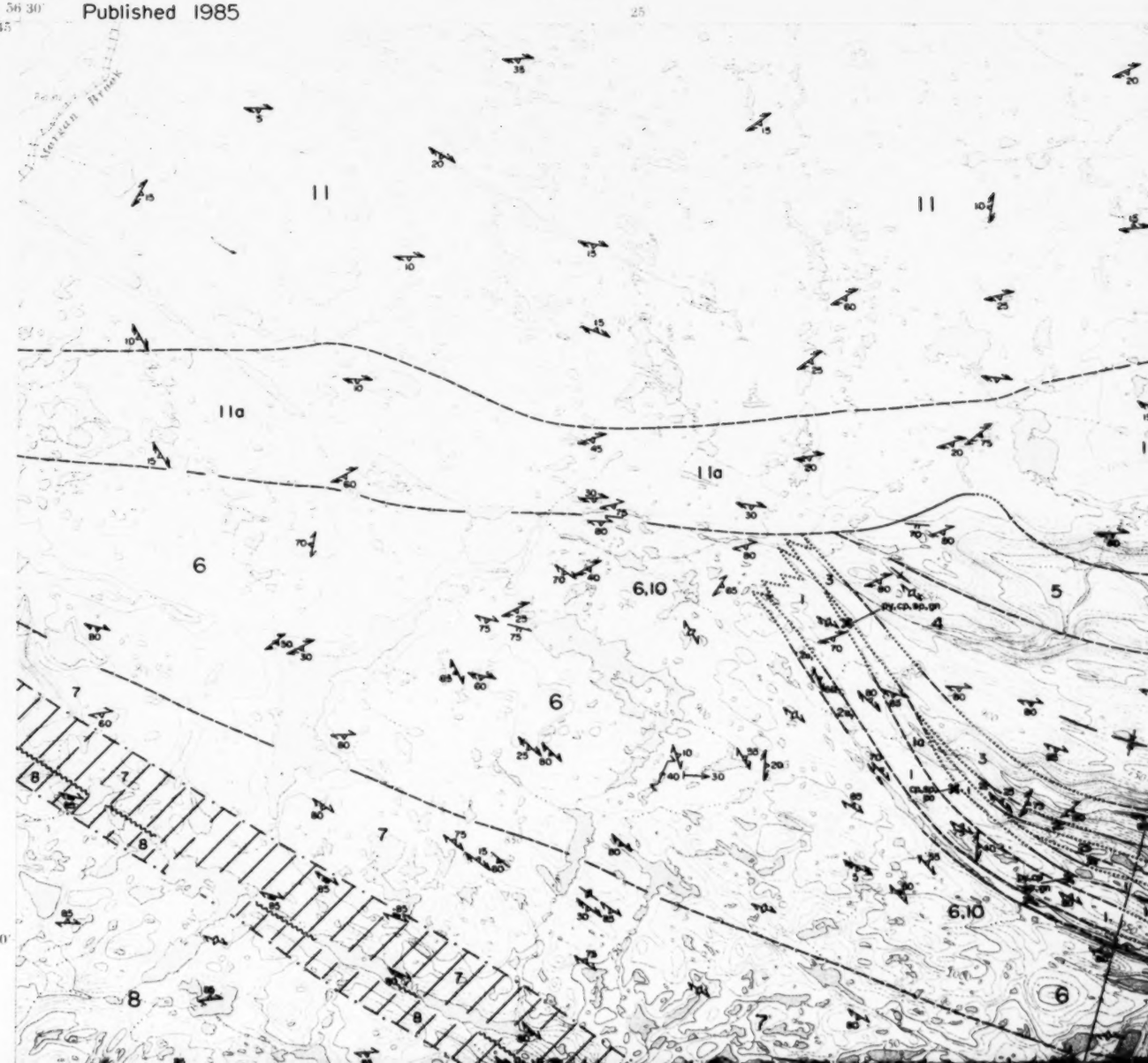
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47 45'

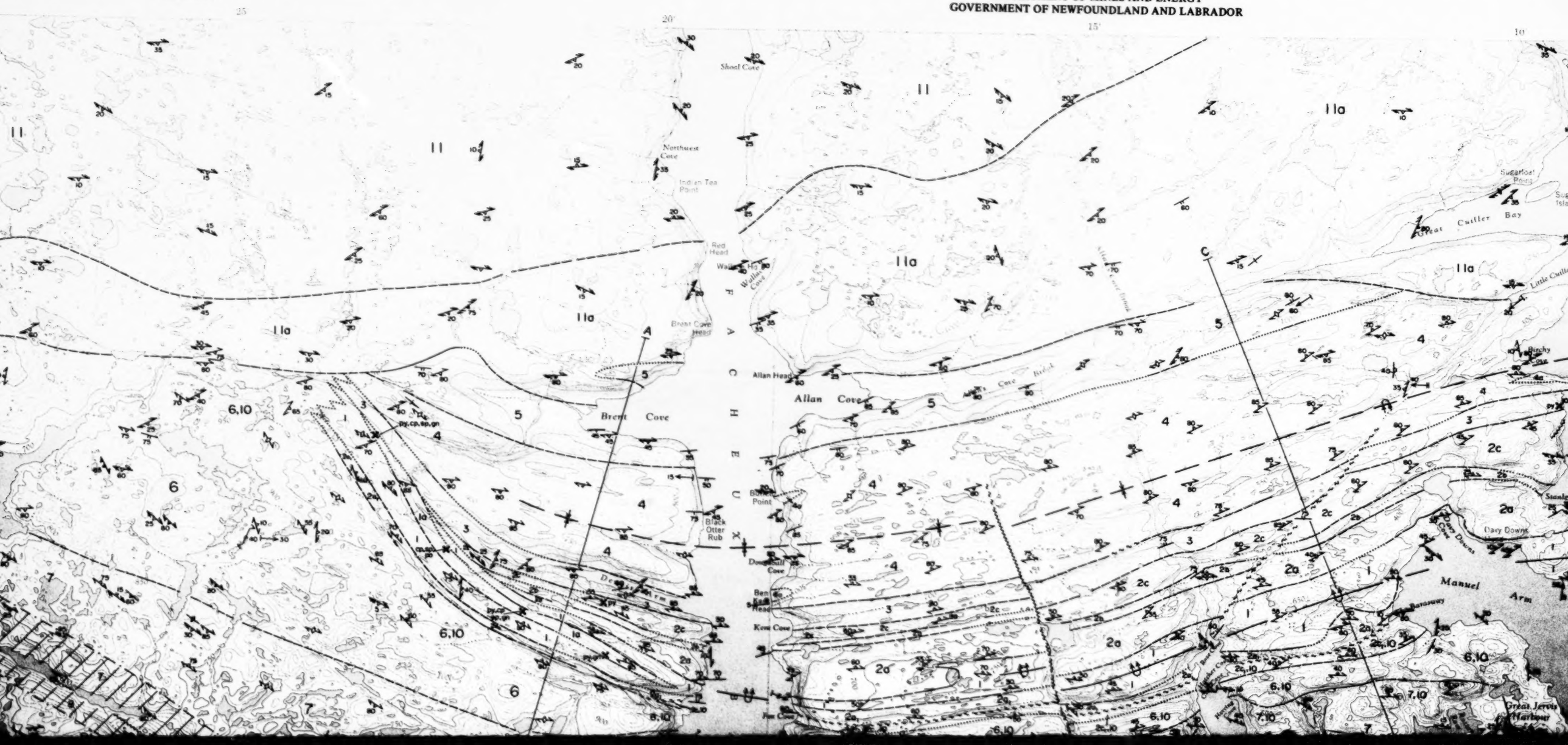
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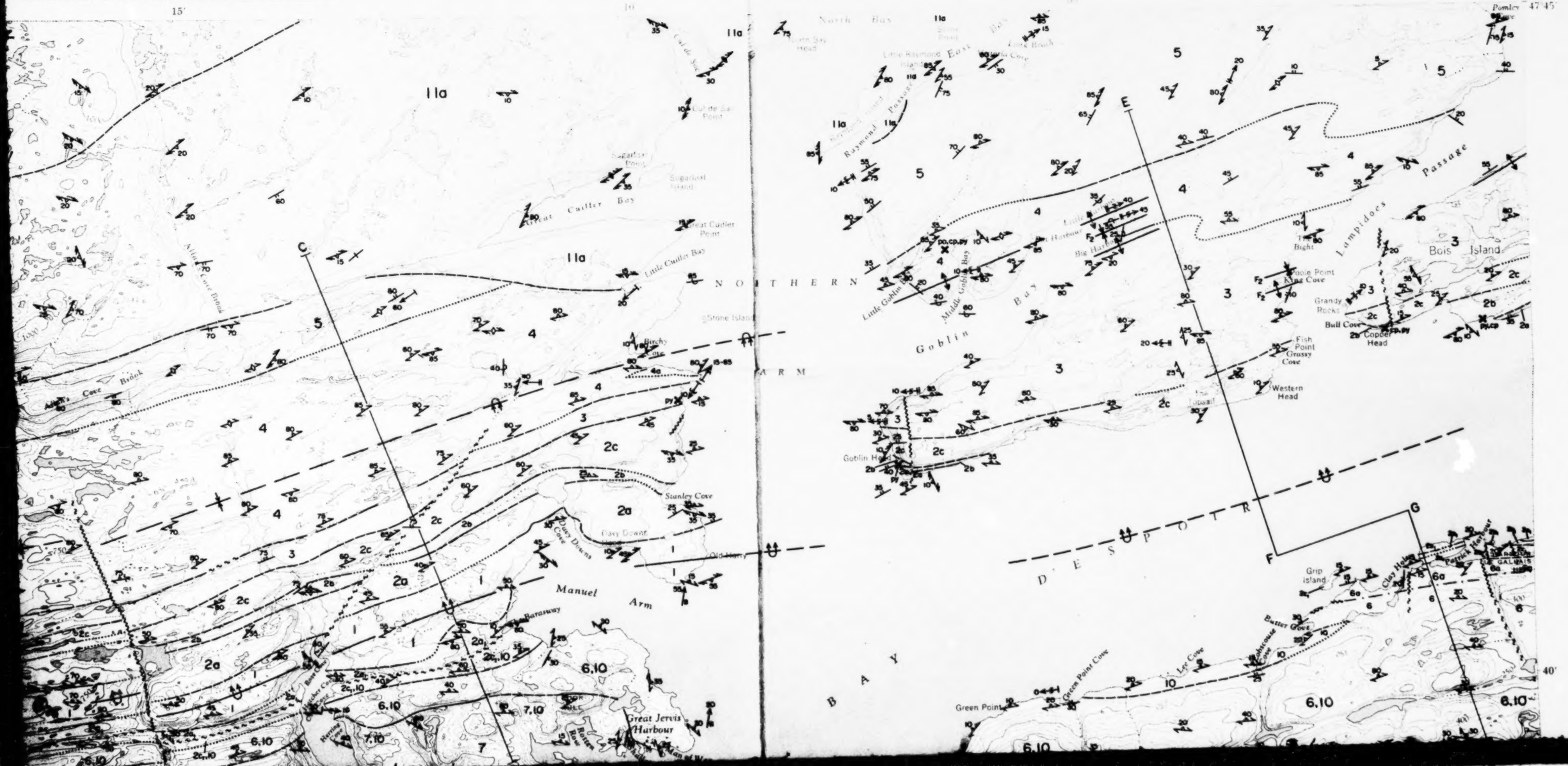
MINERAL DEVELOPMENT DIVISION
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

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MINERAL DEVELOPMENT DIVISION
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

11 P/9



3 *Mostly black graphitic pelite with minor felsic tuff, amphibolite and arenite.*

2 *STANLEY COVE MEMBER: felsic volcanics and minor sedimentary rocks.* **Northern Zone: 2a,** *fine to coarse grained, felsic, lapilli tuff containing variable amounts of quartz and feldspar crystals, massive ash flow tuffs with minor interflow pelite, minor, fine grained, thinly laminated, felsic tuff with scattered quartz crystals, and minor volcanic conglomerate;* **2b,** *black, graphitic pelite with local zones of sandstone, conglomerate and minor marble;* **2c,** *mostly fine grained felsic tuff with few crystal clasts; minor quartz-rich lapilli tuff, mafic tuff, and volcanic conglomerate.* **Southern Zone: $2a_1$,** *fine grained, laminated, felsic, lapilli tuff with scattered quartz and feldspar crystals; locally garnetiferous;* **$2b_1$,** *graphitic pelite, richly garnetiferous;* **$2c_1$,** *recrystallized, locally garnetiferous, felsic tuff; intruded by a profusion of concordant leucogranite veins (50% or more of outcrop area of $2c_1$) in the area west of Manuel Arm, consisting of muscovite-rich, garnetiferous, pegmatite and aplite.*

1 *Gray to black laminated pelite, commonly garnetiferous, with interbedded, minor, fine grained, felsic tuff;* **1a,** *fine grained felsic tuff and sericite phyllite.*

SYMBOLS

- *Geological contact (defined, approximate, assumed, gradational)*
- *Bedding, tops known (inclined, overturned)*
- *Bedding, tops unknown (inclined, vertical)*
- *Overturned F_1 anticline (defined, approximate, assumed)*
- *Overturned F_1 syncline (defined, approximate, assumed)*
- *F_2 antiform (defined)*
- *F_2 synform (defined)*
- *Main, penetrative foliation: S_1 (horizontal, inclined, vertical)*
- *Mylonitic foliation (inclined)*
- *Migmatitic banding (inclined)*
- *Crenulation cleavage to composite foliation in Baie d'Espoir Group; weak fracture cleavage in granitoids: S_2 (inclined, vertical)*
- *Biotite alignment in granitoid (inclined, vertical)*
- *Banding in granite (inclined, vertical)*
- *Mineral lineation*
- *Boudin axis*
- *Minor F_1 fold axis (sense of vergence observed looking along arrow)*
- *Minor F_2 fold axis (sense of vergence observed looking along arrow)*
- *Mylonite zone*
- *Fault (defined, approximate, assumed)*
- *Thrust fault (defined)*
- *Shear fabric (inclined)*
- *Mineral showing* ×

MINERAL OCCURRENCES

- *Pyrite* ..... *py*



DRAGON BAY FAULT

Bay of Exploits

Ben Head

Kent Cove

Fox Cove

Warren Cove

Factories Harbour

Crew Cove

Willis Cove

Mustang Cove

Eastern Head

Western Head

Muddy Hole

Richards Harbour

Bear Head

Upper Shoal Point

Lower Shoal Point

Fish Head

Barasway

Pearl Island

The Brothers

Great Jervis Harbour

Rattling Rock

Rattling Cove

Wild Cove Head

Wild Cove

White Point

Killduck Cove

Brake I

The Burasway

Fishes Nose Point

Pushthrough

BONNE PEAK

Bonne Bay

Hardy Cove

Hardy Pigeon Cove

Buffett Point

Buffett Tickle

Daniel Island

Posie Island

Bonne Bay Harbour

McCallum

Mosquito Harbour

Back Cove

Hardy Point

Rogers Head

Indian Cove Point

Grip Head

Salmon Point

Snag Rocks

Fischots

Sandie Island

Sandie Island

Great Jervis Harbour

Harbour

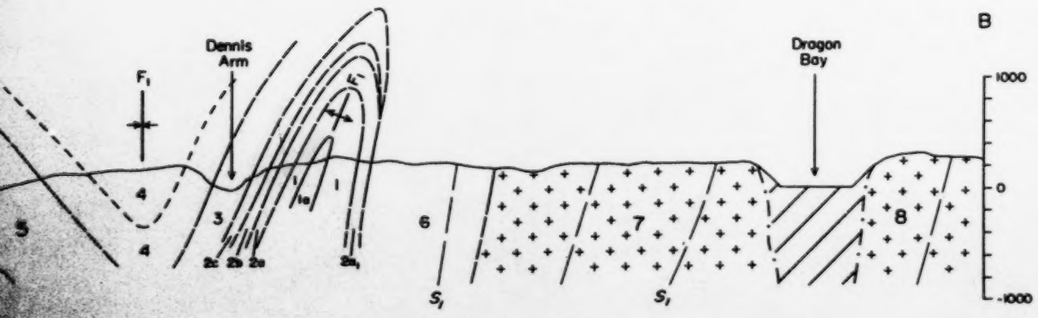
Pushthrough

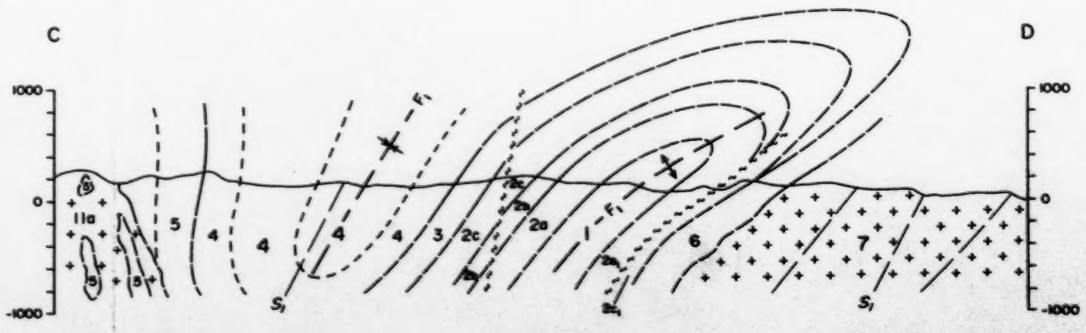
Bonne Bay

Mosquito Harbour

H E R M

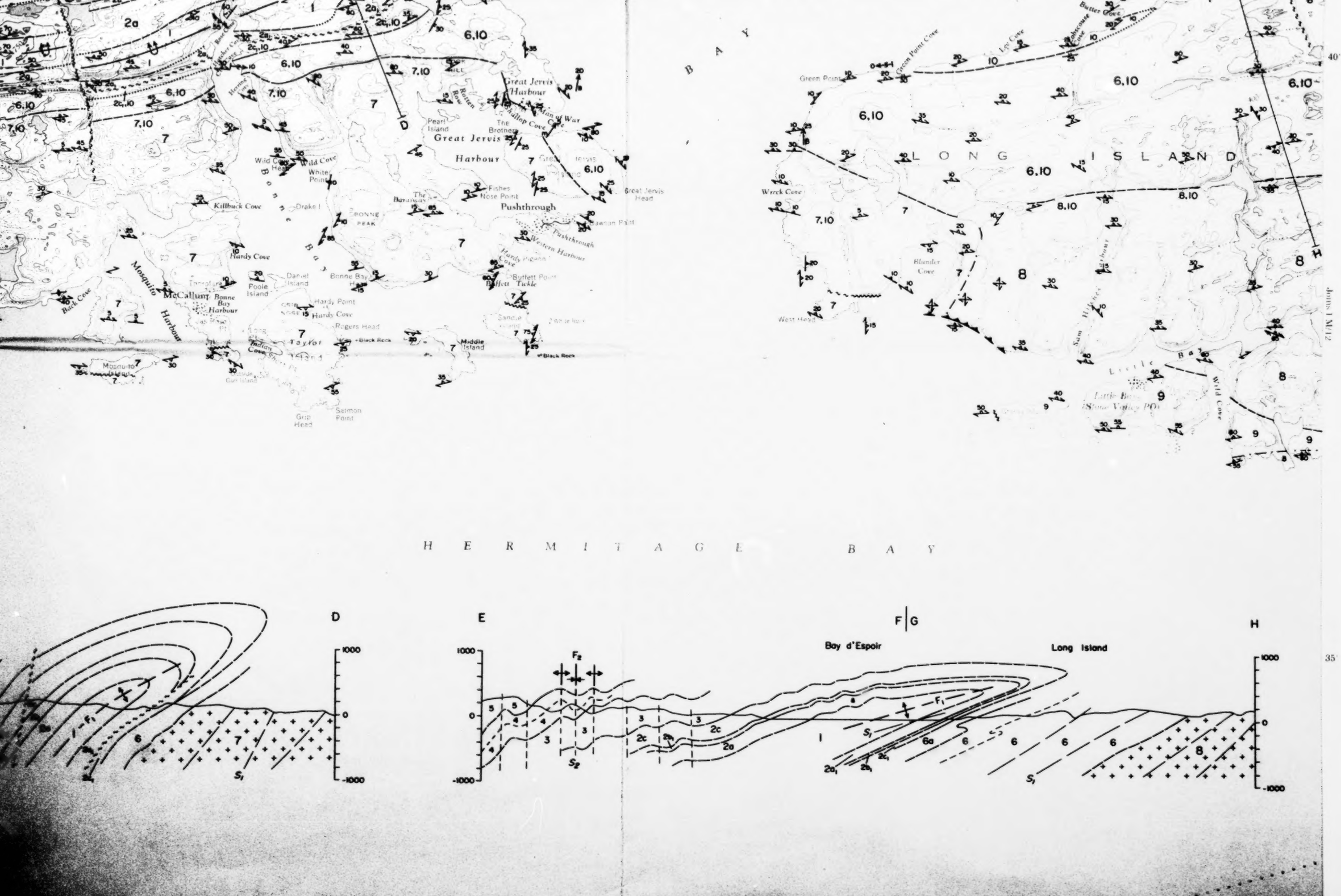
CROSS SECTIONS







H E R M I T A G E B A Y



Biotite alignment in granitoid (inclined, vertical) .....

Banding in granite (inclined, vertical) .....

Mineral lineation .....

Boudin axis .....

Minor F_1 fold axis (sense of vergence observed looking along arrow) .....

Minor F_2 fold axis (sense of vergence observed looking along arrow) .....

Mylonite zone .....

Fault (defined, approximate, assumed) .....

Thrust fault (defined) .....

Shear fabric (inclined) .....

Mineral showing .....

MINERAL OCCURRENCES

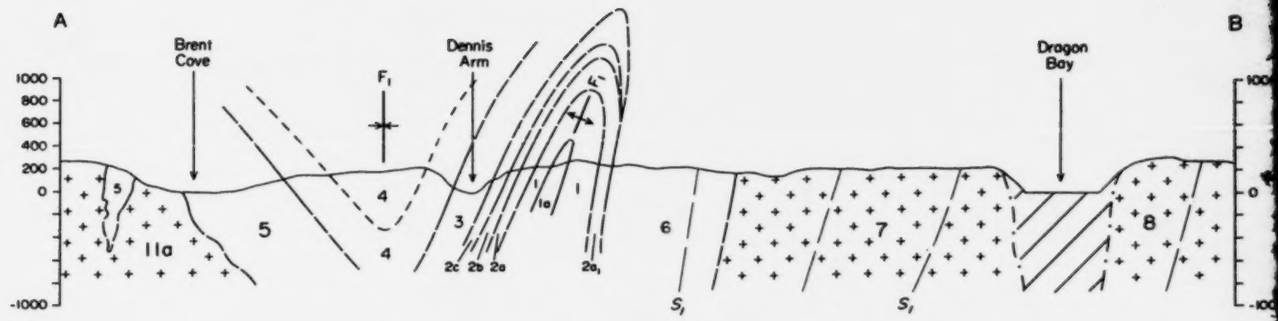
Pyrite ..... py

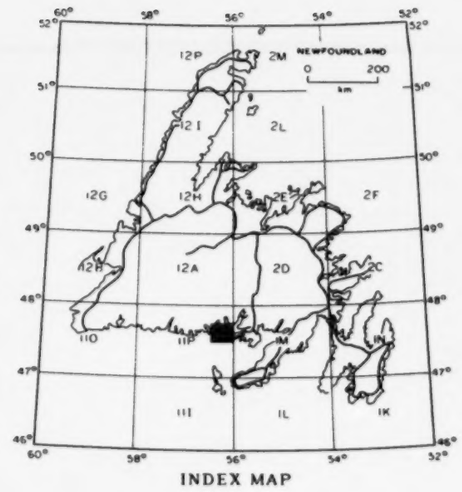
Chalcopyrite ..... cp

Sphalerite ..... sp

Galena ..... gn

Pyrrhotite ..... po





INDEX MAP

Numbers refer to rock

Geological boundary (d

Bedding (diagrammatic

S_1 .....

S_2 .....

Mylonite zone .....

Fault (assumed) .....

Granitoid rocks .....

Geology by R. Frank Blackwood; field assistance was provided by Morris J. West.

Geological cartography by Drafting Section, Mineral Development Division, Department of Mines and Energy, Government of Newfoundland and Labrador.

Copies of this map may be obtained from the Publications and Information Section, Mineral Development Division, Department of Mines and Energy, P.O. Box 4750, St. John's, Newfoundland, A1C 5T7.

Base map at same scale published by the Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa, 1972.

Elevations in feet above mean sea level.

Approximate magnetic declination, 1985, for centre of map, 26°50' west, decreasing 2.6' annually.

This project is a contribution to the Canada-Newfoundland Co-operative Mineral Program 1982-84. Project carried out by Newfoundland Department of Mines and Energy.

17 30

56 30

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DEPARTMENT OF ENERGY, MINES AND RESOURCES
from detailed maps updated from aerial photographs taken in
1966, 1967 and 1968. Printed 1972

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Roads

house or stat... surface, all weather

loose surface, dry weather and ... gravel

unclassified streets

cart track

trail or portage

Routes

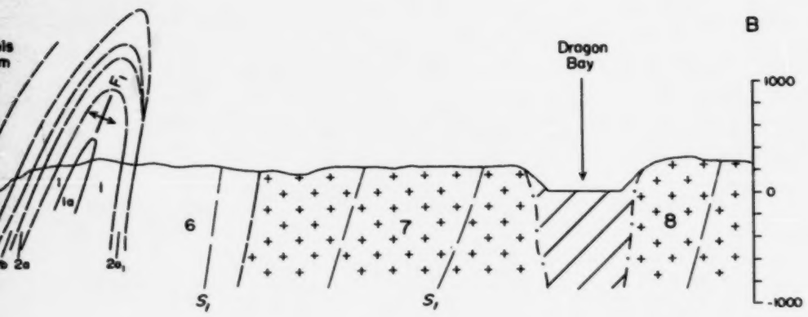
... gravier aggloméré, tou

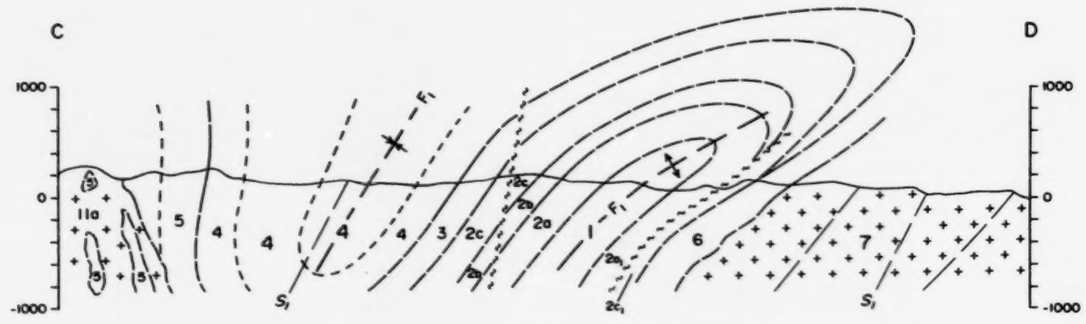
... de gravier, temps sec

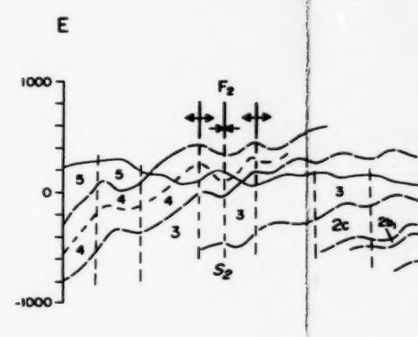
... rues hors classe

... de terre

... sentier ou portage







CROSS SECTIONS

SYMBOLS

Numbers refer to rock units and are the same as those in the map legend

Geological boundary (defined, assumed) .....

Bedding (diagrammatic) .....

S_1 .....

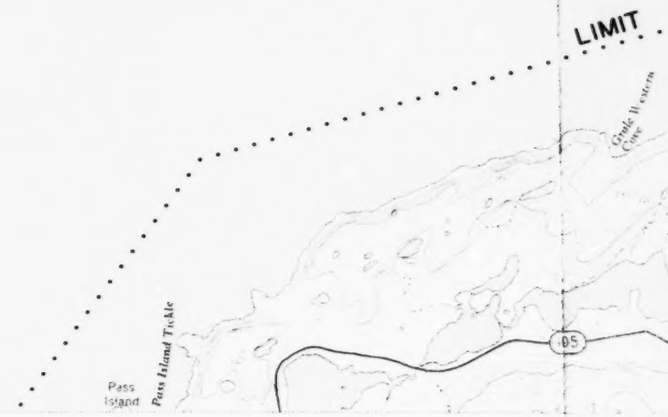
S_2 .....

Mylonite zone .....

Fault (assumed) .....

Granitoid rocks .....





20'

15'

MAP 85-55

FACHEUX BAY

HERMITAGE DISTRICT

NEWFOUNDLAND

Scale 1:50,000 Échelle

Miles 1 0 1 2 3 Miles

Metres 1000 0 1000 2000 3000 4000 Mètres

Yards 1000 0 1000 2000 3000 4000 Verges

This Provisional Map is equivalent to a standard map in accuracy of content.

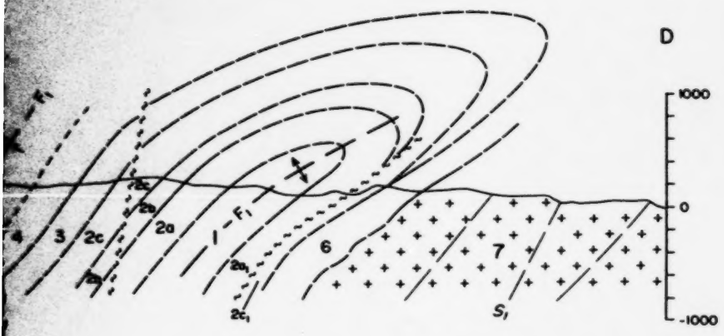
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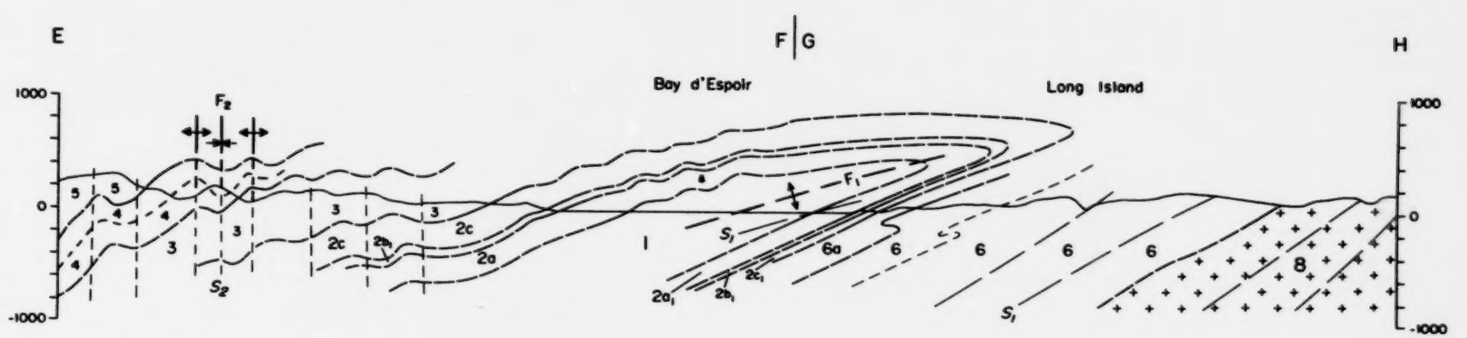
CONTOUR INTERVAL 50 FEET

Elevations in Feet above Mean Sea Level

North American Datum 1927

Transverse Mercator Projection





LIMIT . . . OF . . . MAPPING





MAP 85-55

FACHEUX BAY

HERMITAGE DISTRICT

NEWFOUNDLAND

Scale 1:50,000 Échelle

0 1 2 3 Miles

0 1000 2000 3000 4000 Mètres

0 1000 2000 3000 4000 Verges

This Provisional Map is equivalent to a standard map in accuracy of content.

Some outlines on this map are not yet complete. Corrections or additions are invited by the Surveys and Mapping Branch.

CONTOUR INTERVAL 50 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection